Fig.1

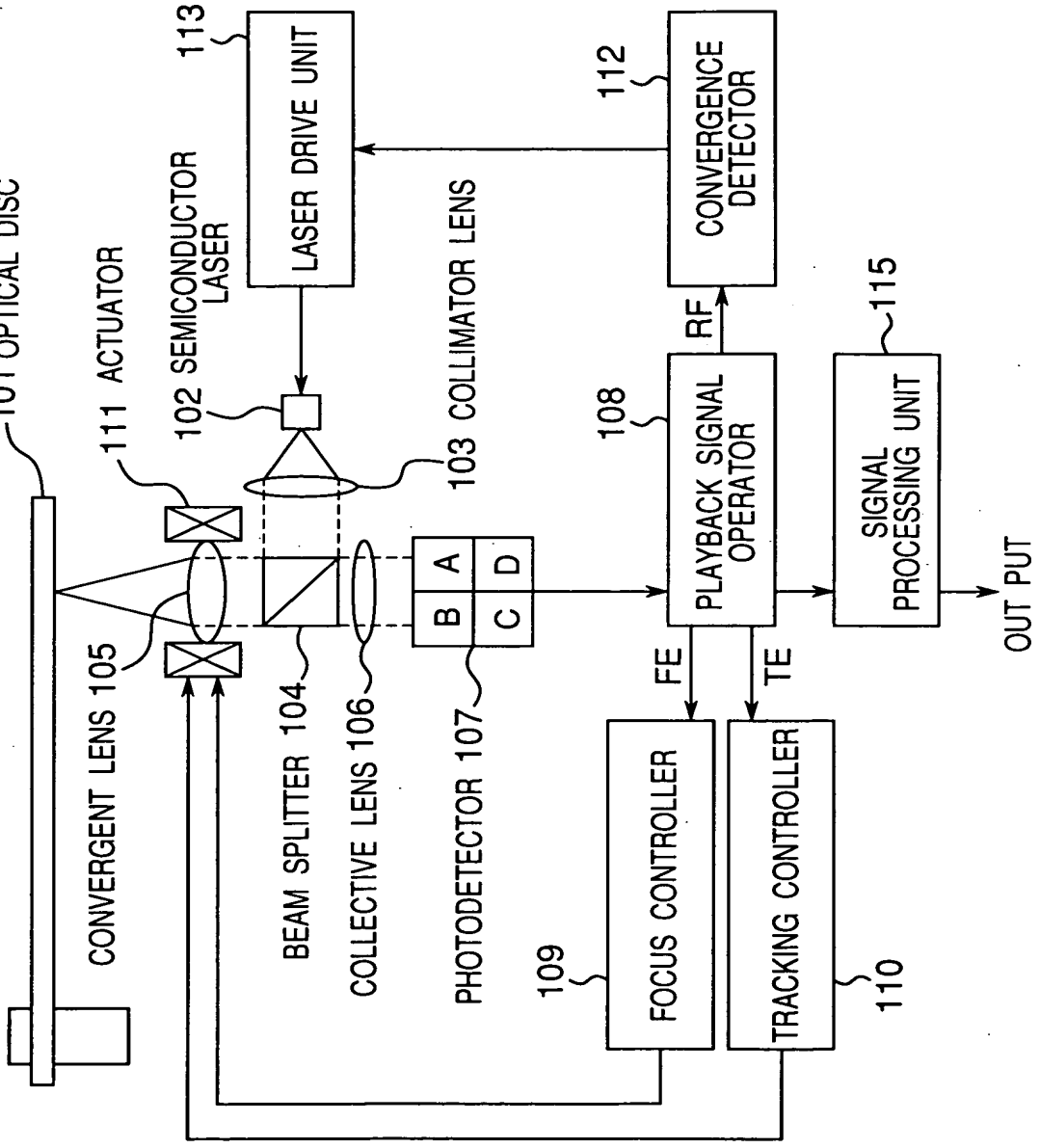

101 OPTICAL DISC
111 ACTUATOR
102 SEMICONDUCTOR LASER
113
LASER DRIVE UNIT
112
CONVERGENCE DETECTOR
103 COLLIMATOR LENS
108
PLAYBACK SIGNAL OPERATOR
RF
115
SIGNAL PROCESSING UNIT
OUT PUT
CONVERGENT LENS 105
BEAM SPLITTER 104
COLLECTIVE LENS 106
PHOTODETECTOR 107
A
B
C
D
FE
TE
109
FOCUS CONTROLLER
TRACKING CONTROLLER
110

Fig.2

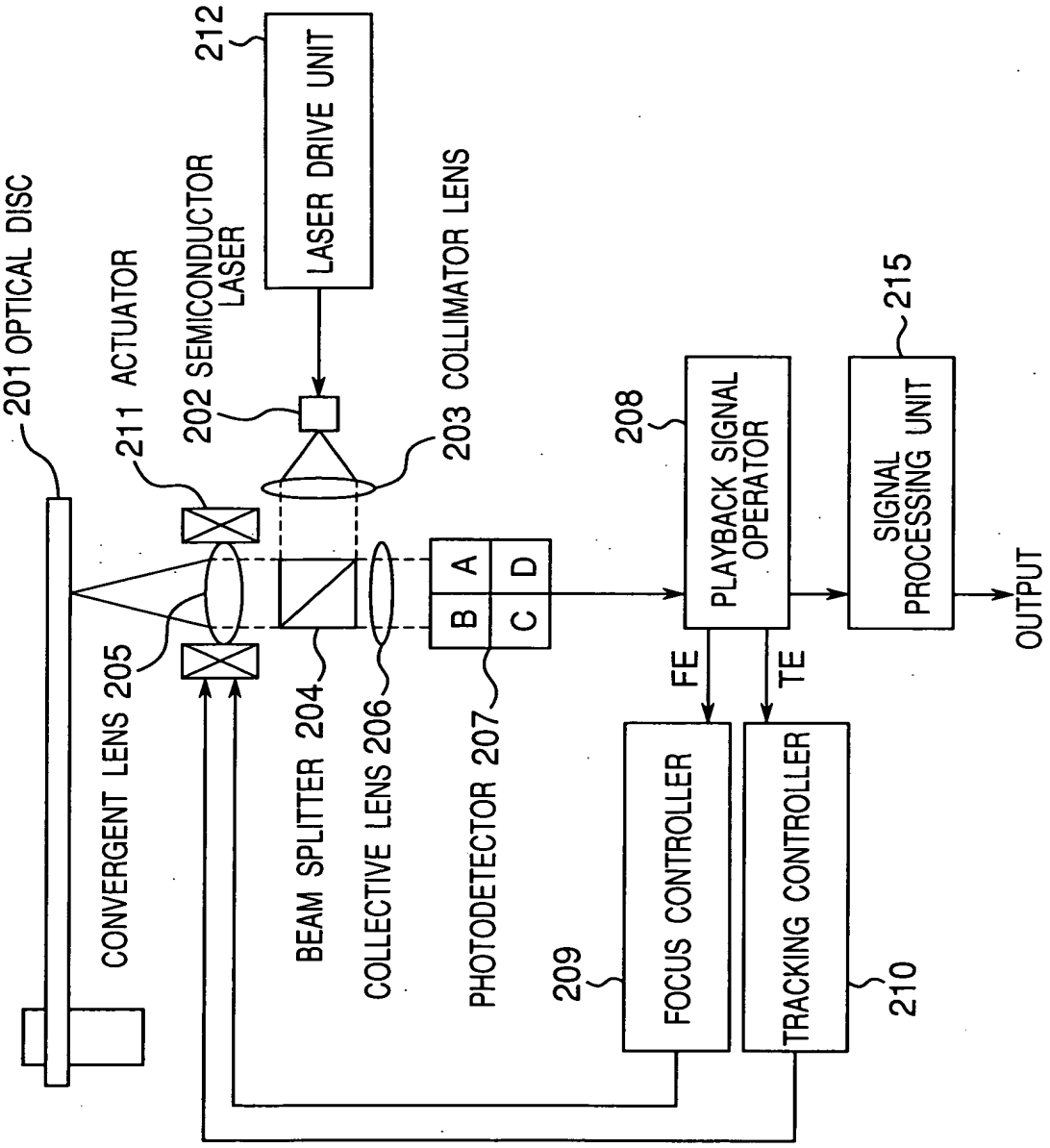
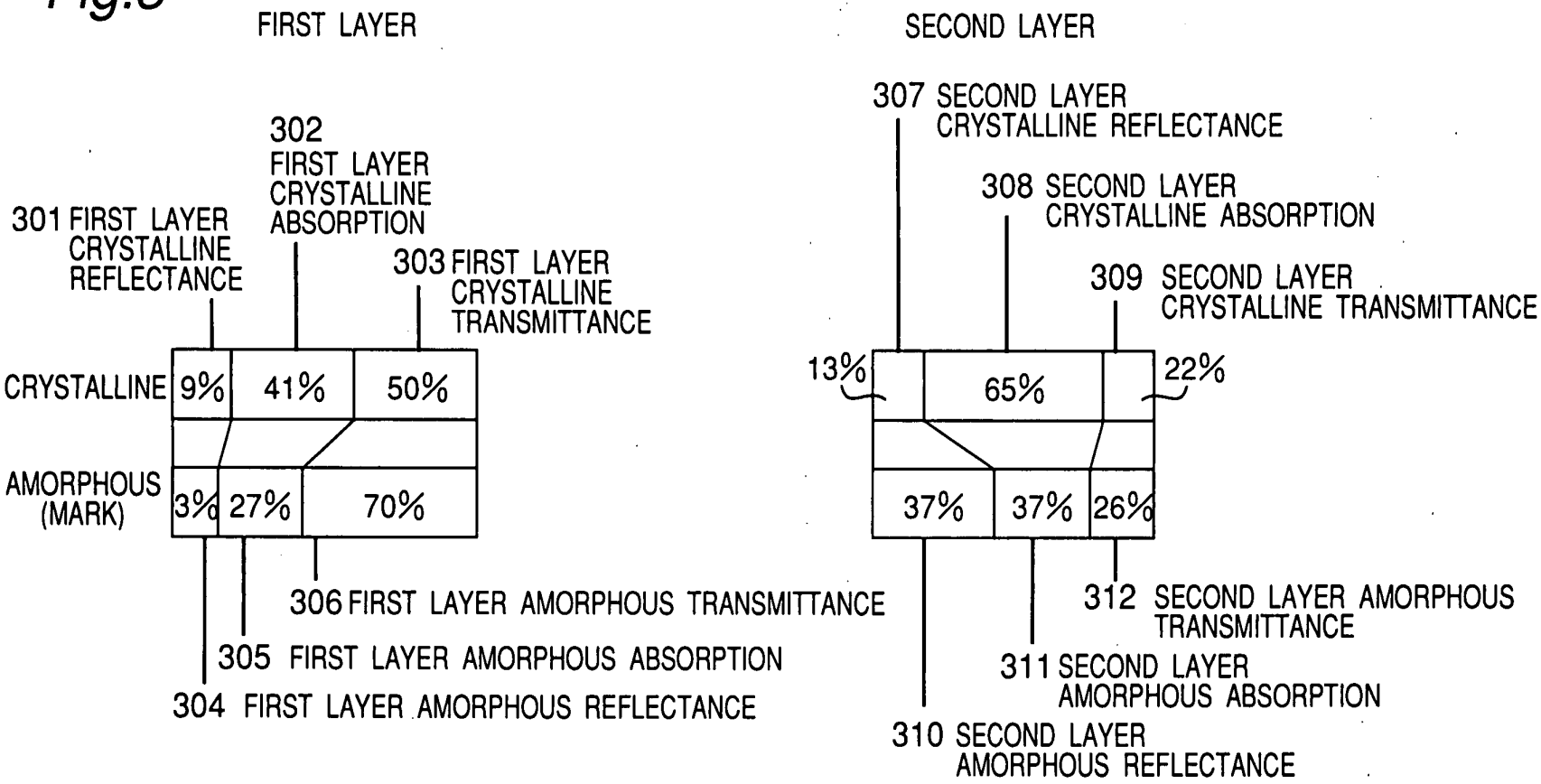

201 OPTICAL DISC
211 ACTUATOR
202 SEMICONDUCTOR LASER
212
LASER DRIVE UNIT
203 COLLIMATOR LENS
208
PLAYBACK SIGNAL OPERATOR
215
SIGNAL PROCESSING UNIT
OUTPUT
CONVERGENT LENS 205
BEAM SPLITTER 204
COLLECTIVE LENS 206
PHOTODETECTOR 207
A
B
C
D
FE
TE
209
FOCUS CONTROLLER
TRACKING CONTROLLER
210

Fig.3



$\Delta R1 = 6\%$

$\Delta R2 = -24\% \times 0.5 \times 0.5 = -6\%$

Fig.4

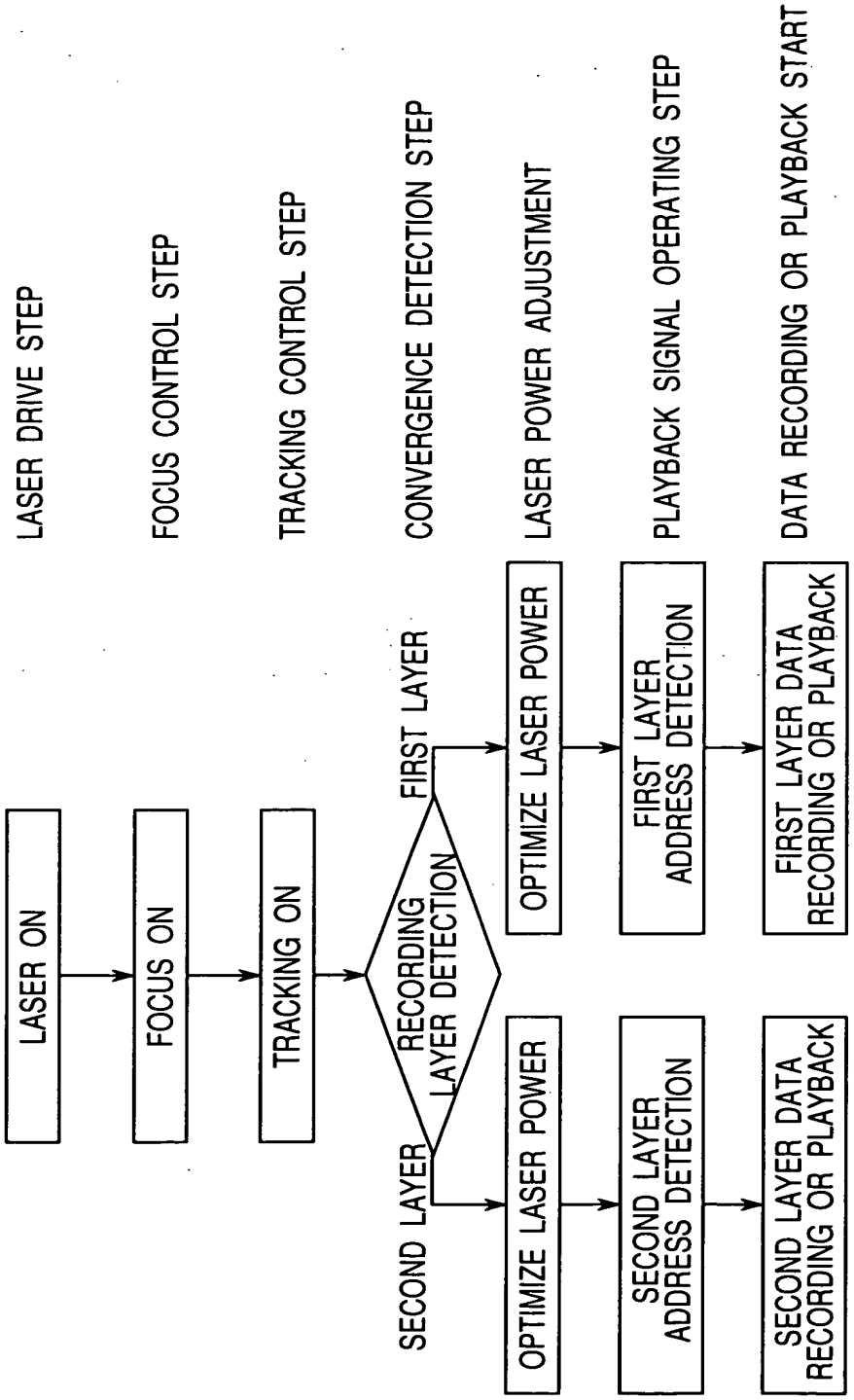

LASER ON
FOCUS ON
TRACKING ON
RECORDING LAYER DETECTION
FIRST LAYER
SECOND LAYER
OPTIMIZE LASER POWER
SECOND LAYER ADDRESS DETECTION
SECOND LAYER DATA RECORDING OR PLAYBACK
OPTIMIZE LASER POWER
FIRST LAYER ADDRESS DETECTION
FIRST LAYER DATA RECORDING OR PLAYBACK
LASER DRIVE STEP
FOCUS CONTROL STEP
TRACKING CONTROL STEP
CONVERGENCE DETECTION STEP
LASER POWER ADJUSTMENT
PLAYBACK SIGNAL OPERATING STEP
DATA RECORDING OR PLAYBACK START

Fig.5

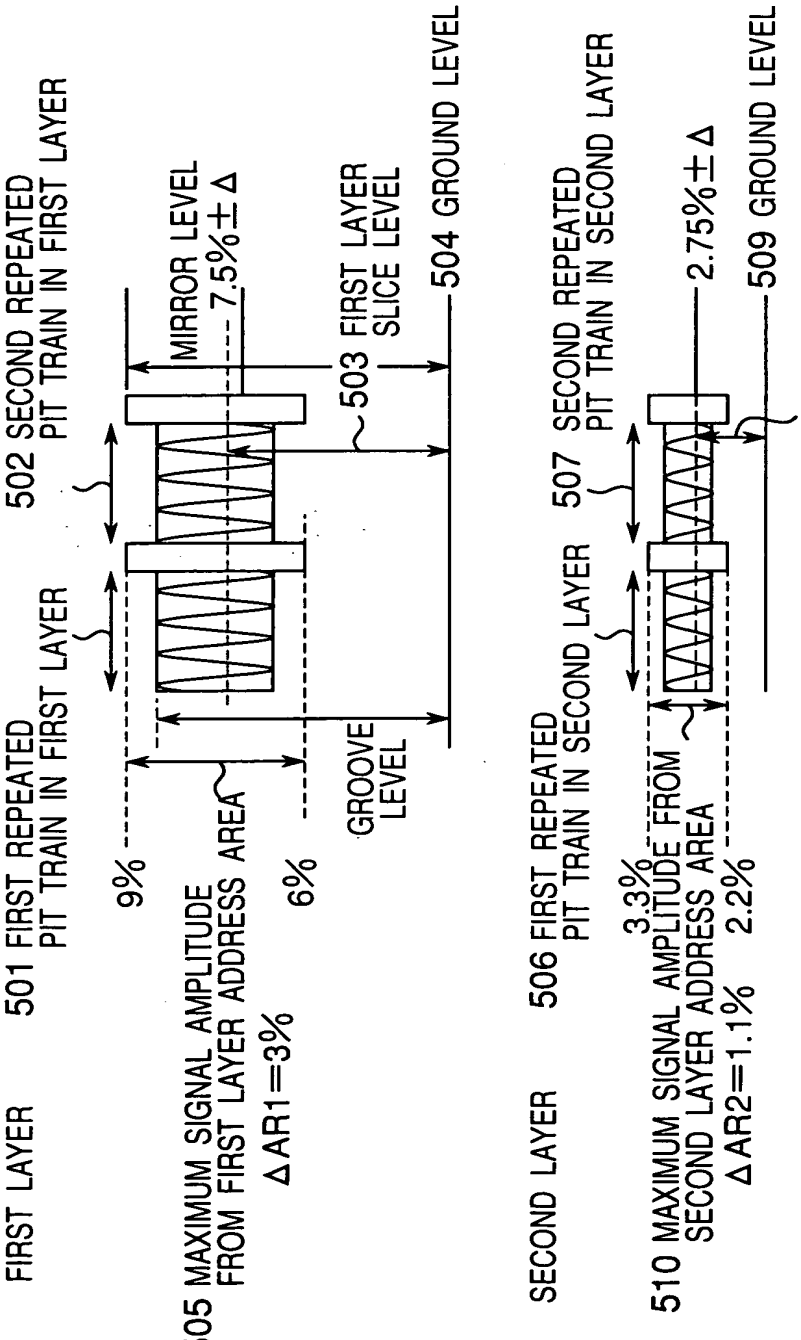

FIRST LAYER
501 FIRST REPEATED PIT TRAIN IN FIRST LAYER
502 SECOND REPEATED PIT TRAIN IN FIRST LAYER
MIRROR LEVEL
7.5%±Δ
503 FIRST LAYER SLICE LEVEL
504 GROUND LEVEL
9%
505 MAXIMUM SIGNAL AMPLITUDE FROM FIRST LAYER ADDRESS AREA
ΔAR1=3%
6%
GROOVE LEVEL
SECOND LAYER
506 FIRST REPEATED PIT TRAIN IN SECOND LAYER
507 SECOND REPEATED PIT TRAIN IN SECOND LAYER
2.75%±Δ
509 GROUND LEVEL
508 SECOND LAYER SLICE LEVEL
3.3%
510 MAXIMUM SIGNAL AMPLITUDE FROM SECOND LAYER ADDRESS AREA
ΔAR2=1.1%
2.2%

Fig.6

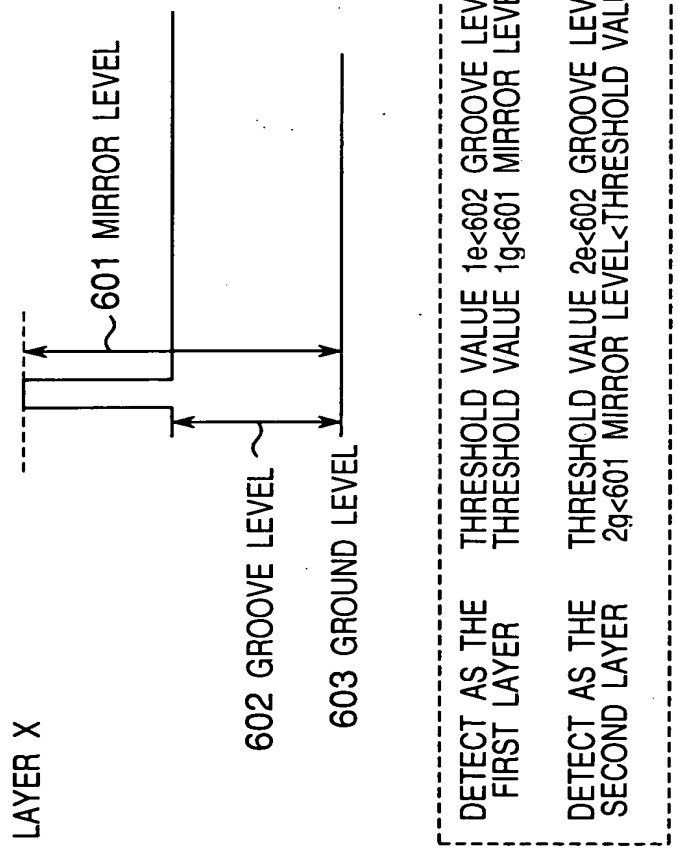
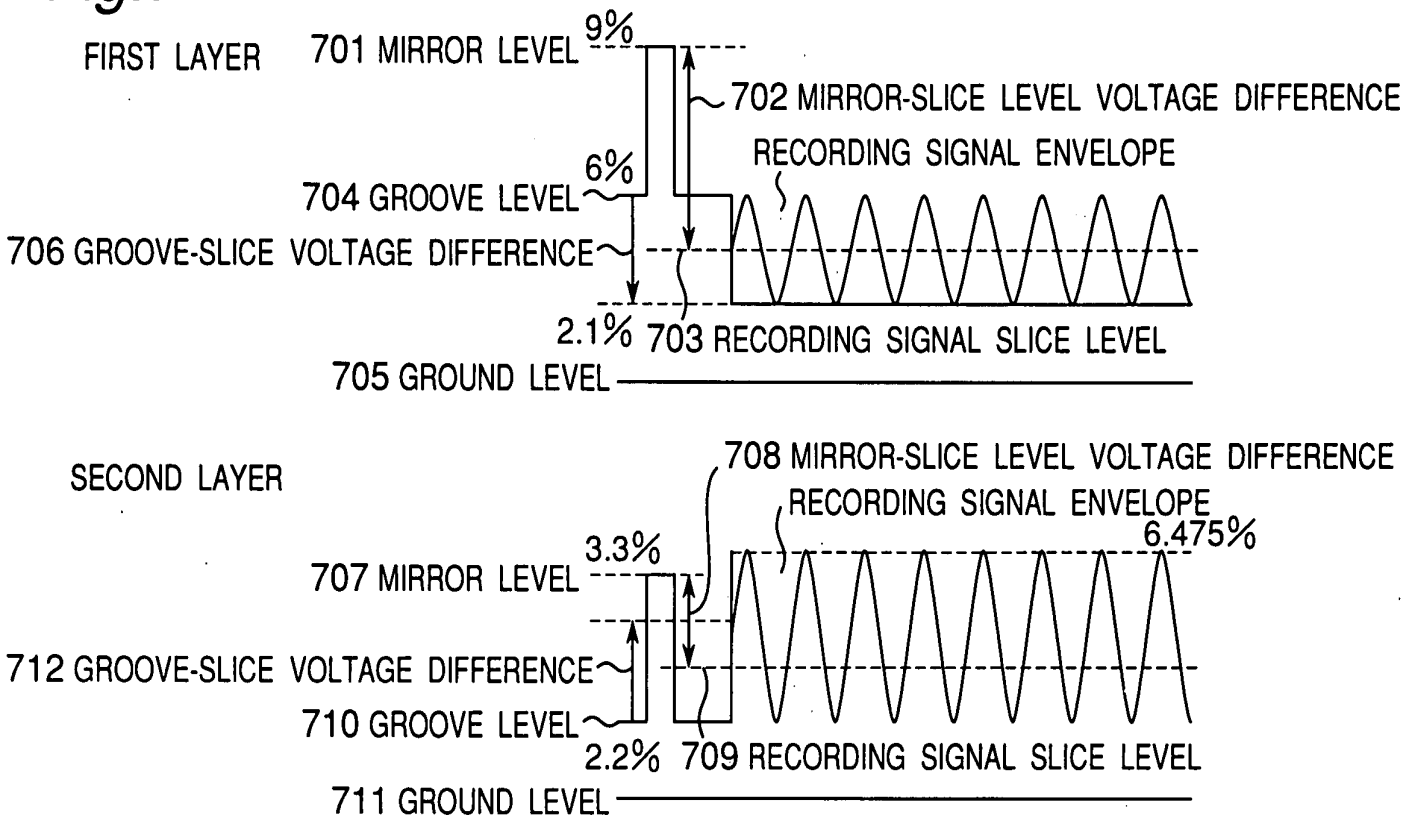

LAYER X
601 MIRROR LEVEL
602 GROOVE LEVEL
603 GROUND LEVEL
DETECT AS THE FIRST LAYER
THRESHOLD VALUE 1e<602 GROOVE LEVEL<THRESHOLD VALUE 1f OR
THRESHOLD VALUE 1g<601 MIRROR LEVEL<THRESHOLD VALUE 1h
DETECT AS THE SECOND LAYER
THRESHOLD VALUE 2e<602 GROOVE LEVEL<THRESHOLD VALUE 2f OR
2g<601 MIRROR LEVEL<THRESHOLD VALUE 2h

Fig.7



DETECT AS THE FIRST LAYER	THRESHOLD VALUE 1i<MIRROR-SLICE LEVEL VOLTAGE DIFFERENCE<THRESHOLD VALUE 1j OR 0<GROOVE-SLICE VOLTAGE DIFFERENCE
DETECT AS THE SECOND LAYER	THRESHOLD VALUE 2i<MIRROR-SLICE LEVEL VOLTAGE DIFFERENCE<THRESHOLD VALUE 2j OR 0>GROOVE-SLICE VOLTAGE DIFFERENCE

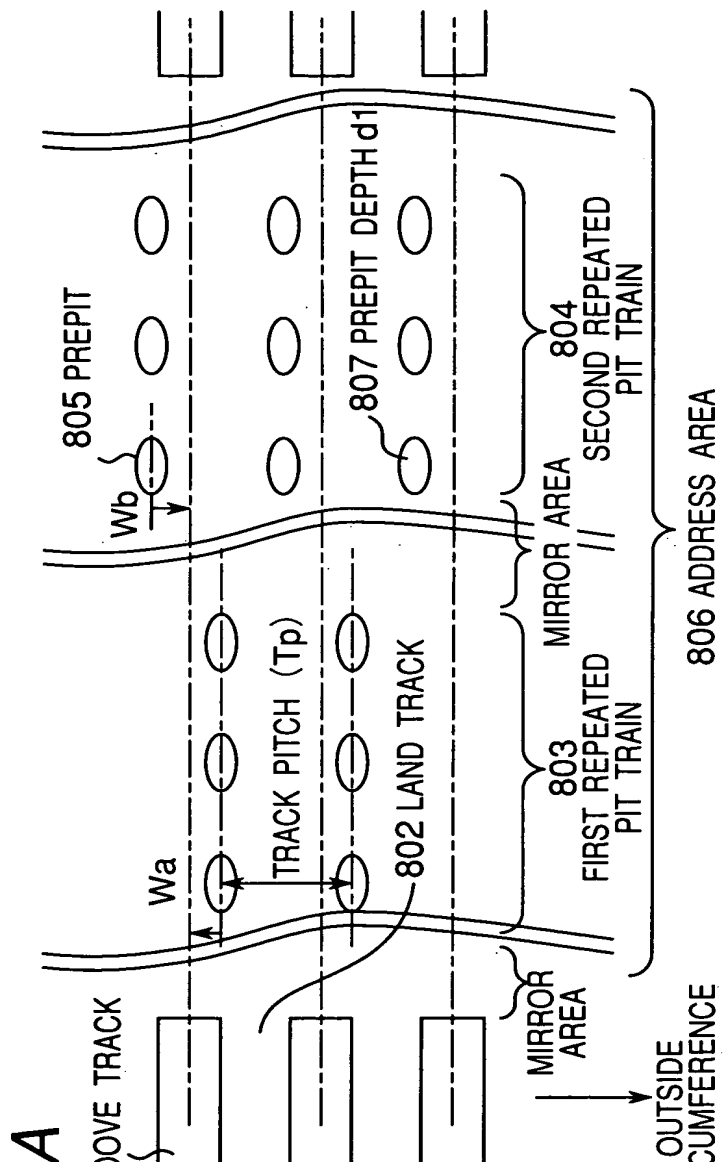


Fig.8A

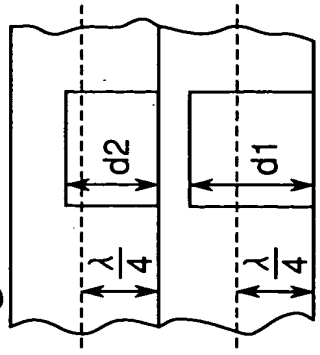


Fig.8D

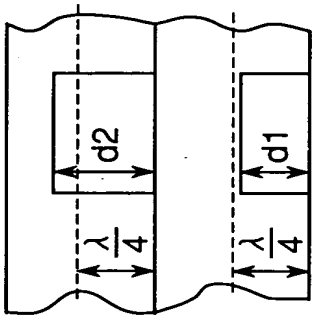


Fig.8C

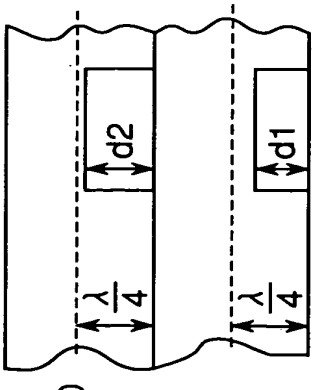


Fig.8B

Fig.9

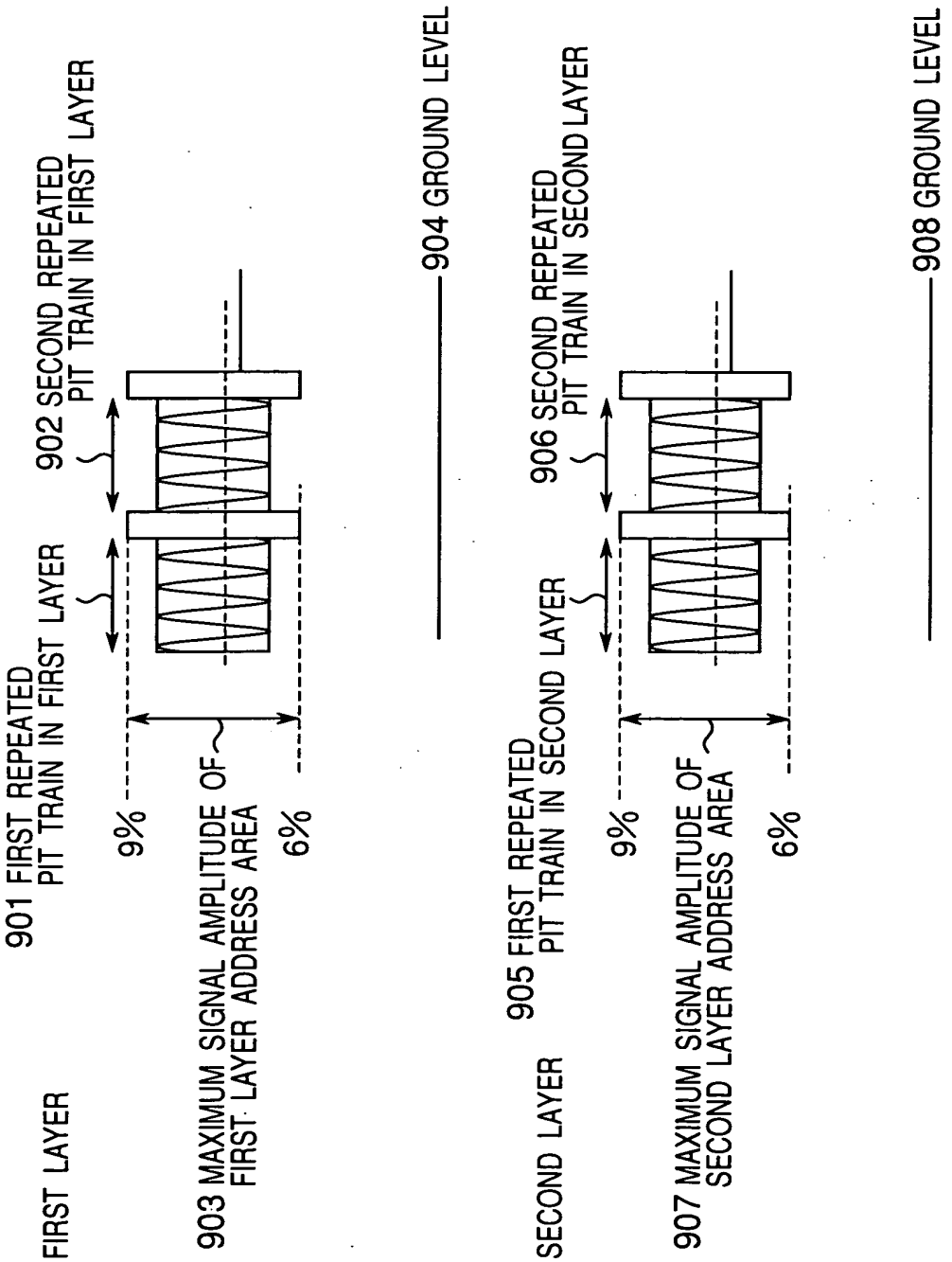
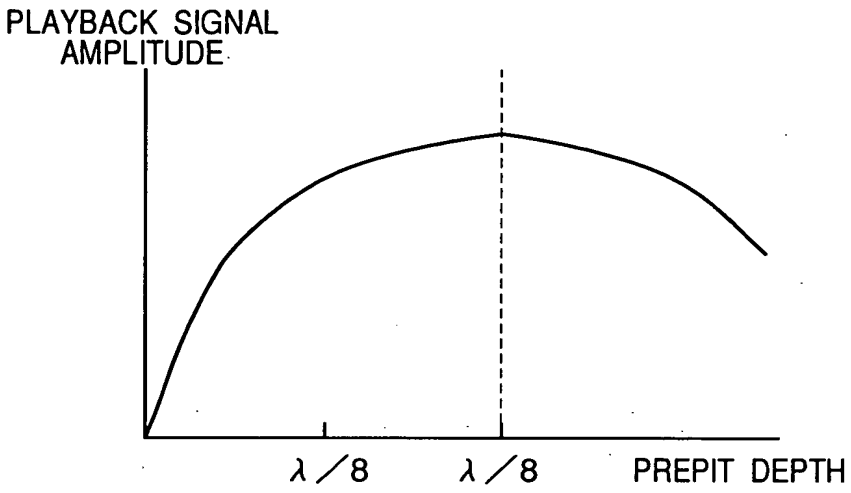

FIRST LAYER
901 FIRST REPEATED PIT TRAIN IN FIRST LAYER
902 SECOND REPEATED PIT TRAIN IN FIRST LAYER
903 MAXIMUM SIGNAL AMPLITUDE OF FIRST LAYER ADDRESS AREA
9%
6%
904 GROUND LEVEL
SECOND LAYER
905 FIRST REPEATED PIT TRAIN IN SECOND LAYER
906 SECOND REPEATED PIT TRAIN IN SECOND LAYER
907 MAXIMUM SIGNAL AMPLITUDE OF SECOND LAYER ADDRESS AREA
9%
6%
908 GROUND LEVEL

Fig.10



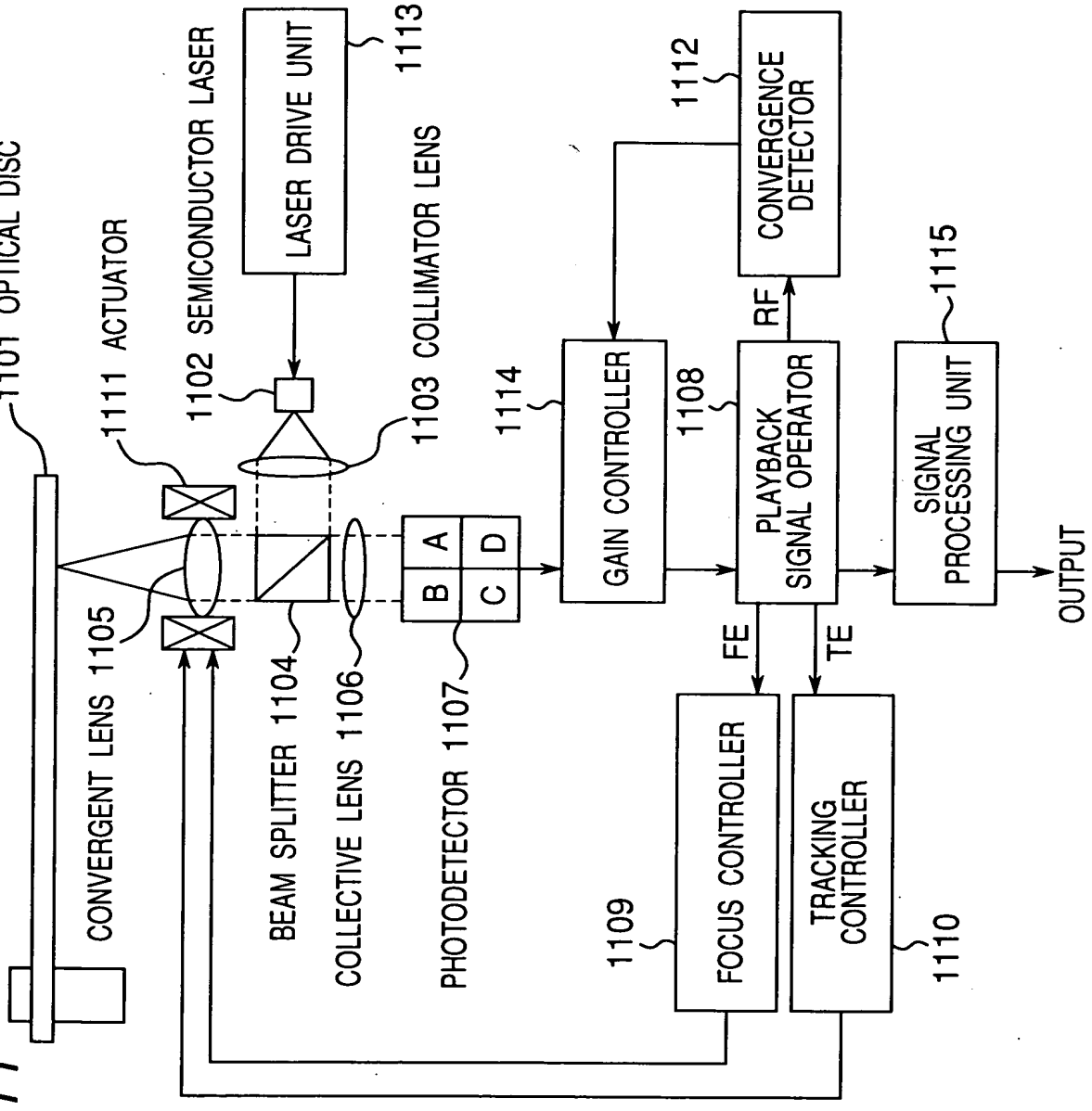

1101 OPTICAL DISC
1111 ACTUATOR
1102 SEMICONDUCTOR LASER
LASER DRIVE UNIT
1113
1103 COLLIMATOR LENS
1112
CONVERGENCE DETECTOR
1114
GAIN CONTROLLER
1108
PLAYBACK SIGNAL OPERATOR
RF
1115
SIGNAL PROCESSING UNIT
OUTPUT
CONVERGENT LENS 1105
BEAM SPLITTER 1104
COLLECTIVE LENS 1106
PHOTODETECTOR 1107
A
B
C
D
FE
TE
1109
FOCUS CONTROLLER
TRACKING CONTROLLER
1110

Fig. 11

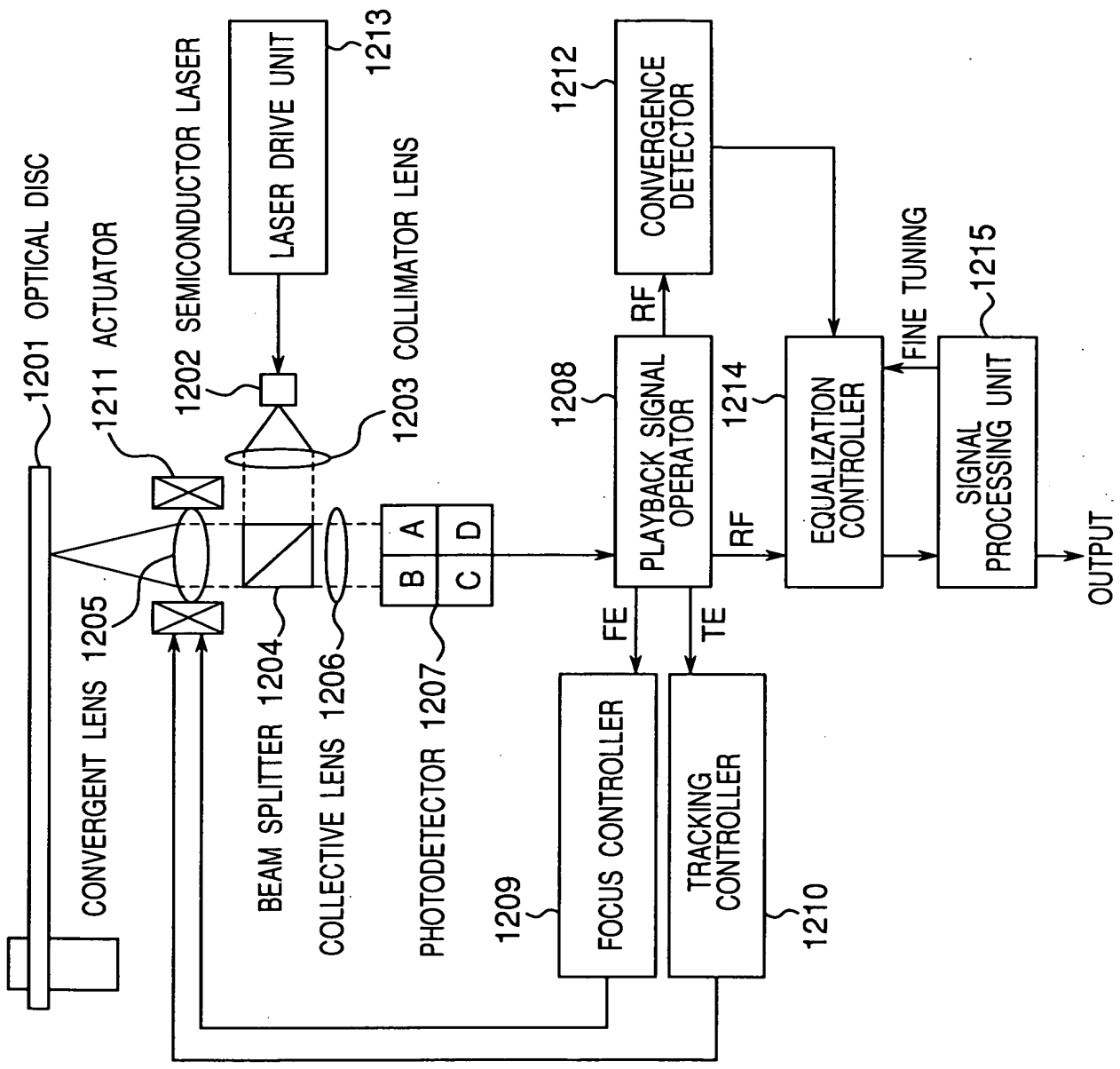

1201 OPTICAL DISC
1211 ACTUATOR
1202 SEMICONDUCTOR LASER
LASER DRIVE UNIT
1213
1203 COLLIMATOR LENS
1212
CONVERGENCE DETECTOR
1208
PLAYBACK SIGNAL OPERATOR
RF
1214
EQUALIZATION CONTROLLER
FINE TUNING
1215
SIGNAL PROCESSING UNIT
OUTPUT
CONVERGENT LENS 1205
BEAM SPLITTER 1204
COLLECTIVE LENS 1206
PHOTODETECTOR 1207
A
B
C
D
FE
TE
1209
FOCUS CONTROLLER
TRACKING CONTROLLER
1210

Fig.12

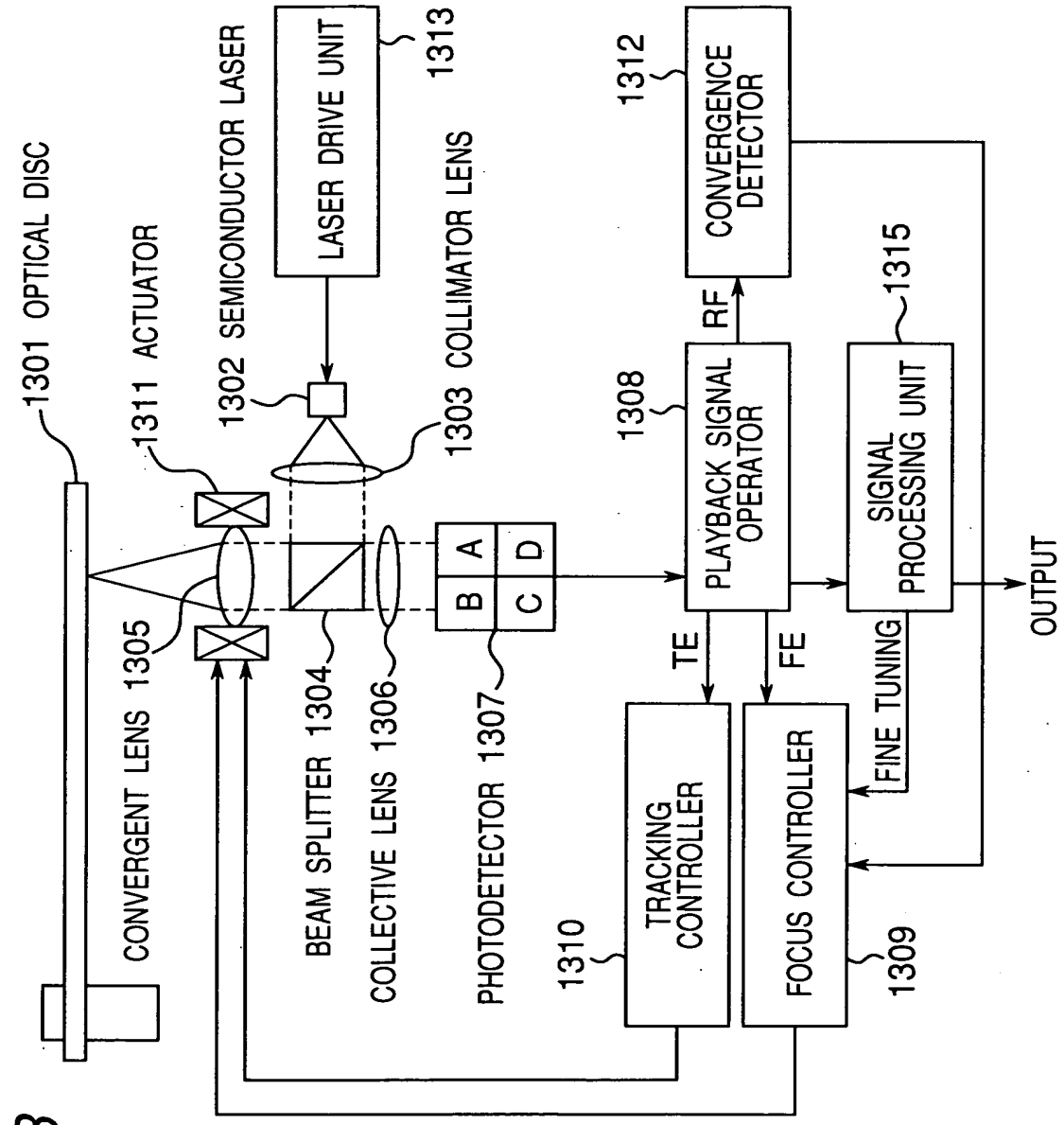

1301 OPTICAL DISC
1311 ACTUATOR
1302 SEMICONDUCTOR LASER
LASER DRIVE UNIT
1313
1303 COLLIMATOR LENS
1312
CONVERGENCE DETECTOR
1315
RF
1308
PLAYBACK SIGNAL OPERATOR
SIGNAL PROCESSING UNIT
OUTPUT
CONVERGENT LENS 1305
BEAM SPLITTER 1304
COLLECTIVE LENS 1306
PHOTODETECTOR 1307
A
B
C
D
TE
FE
FINE TUNING
1310
TRACKING CONTROLLER
FOCUS CONTROLLER
1309

Fig. 13

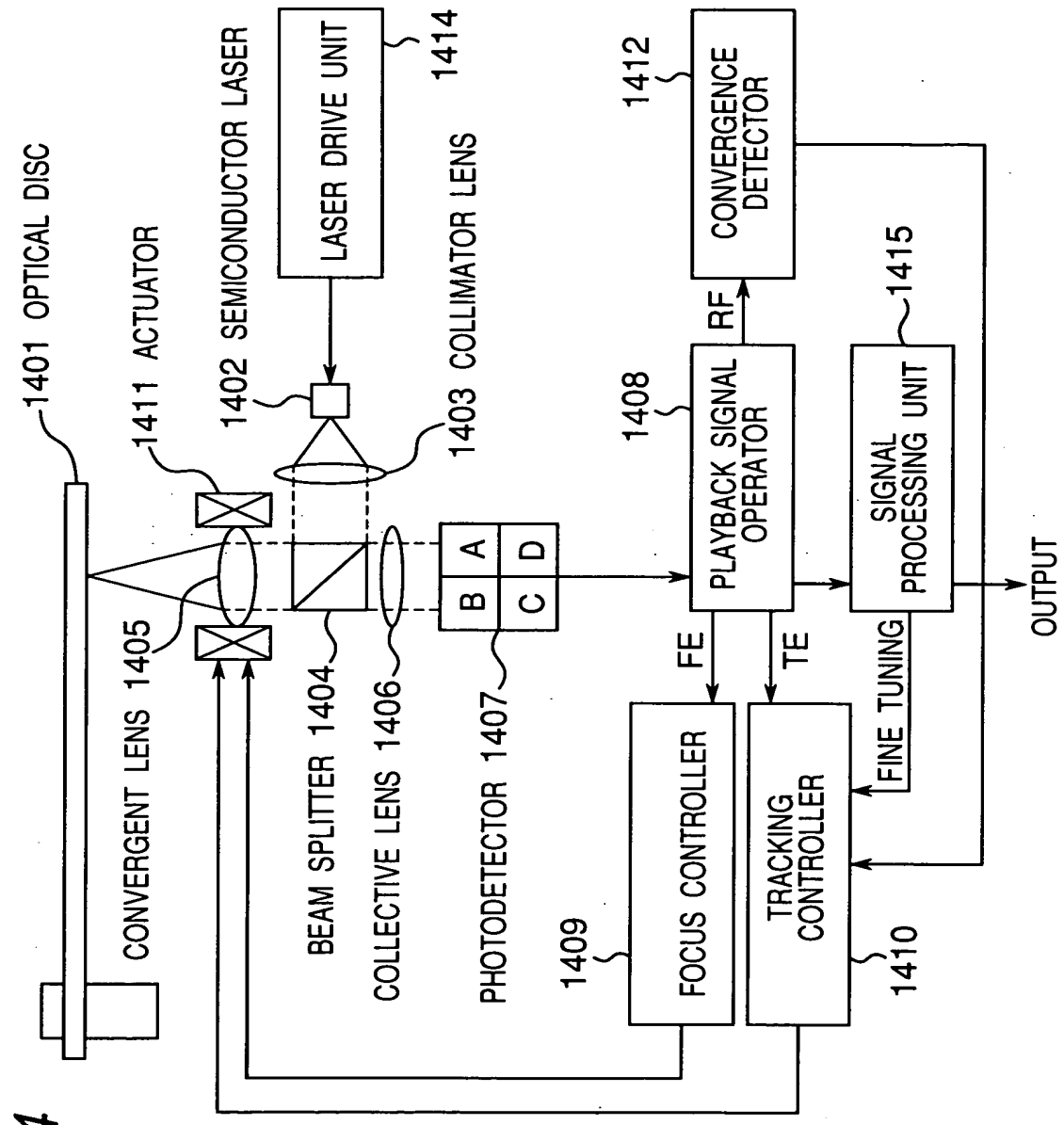

1401 OPTICAL DISC
1411 ACTUATOR
1402 SEMICONDUCTOR LASER
LASER DRIVE UNIT
1414
1403 COLLIMATOR LENS
1412
CONVERGENCE DETECTOR
1408
PLAYBACK SIGNAL OPERATOR
RF
1415
SIGNAL PROCESSING UNIT
OUTPUT
CONVERGENT LENS 1405
BEAM SPLITTER 1404
COLLECTIVE LENS 1406
PHOTODETECTOR 1407
A
B
C
D
FE
TE
FINE TUNING
1409
FOCUS CONTROLLER
TRACKING CONTROLLER
1410

Fig.14

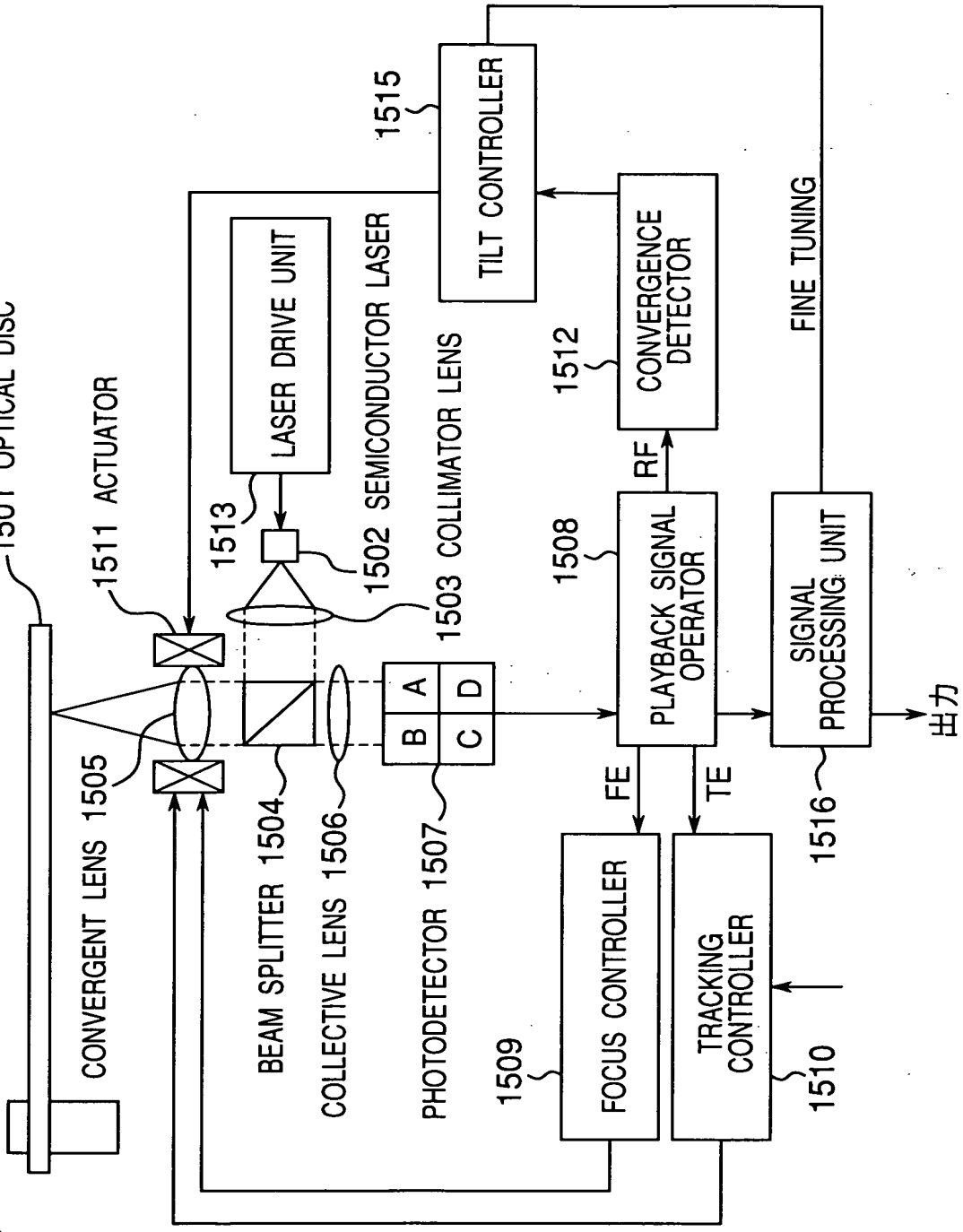

1501 OPTICAL DISC
1511 ACTUATOR
1513
LASER DRIVE UNIT
1502 SEMICONDUCTOR LASER
1503 COLLIMATOR LENS
1515
TILT CONTROLLER
1512
CONVERGENCE DETECTOR
FINE TUNING
RF
1508
PLAYBACK SIGNAL OPERATOR
SIGNAL PROCESSING UNIT
出力
CONVERGENT LENS 1505
BEAM SPLITTER 1504
COLLECTIVE LENS 1506
PHOTODETECTOR 1507
A
B
C
D
FE
TE
1509
FOCUS CONTROLLER
TRACKING CONTROLLER
1510
1516

Fig.15

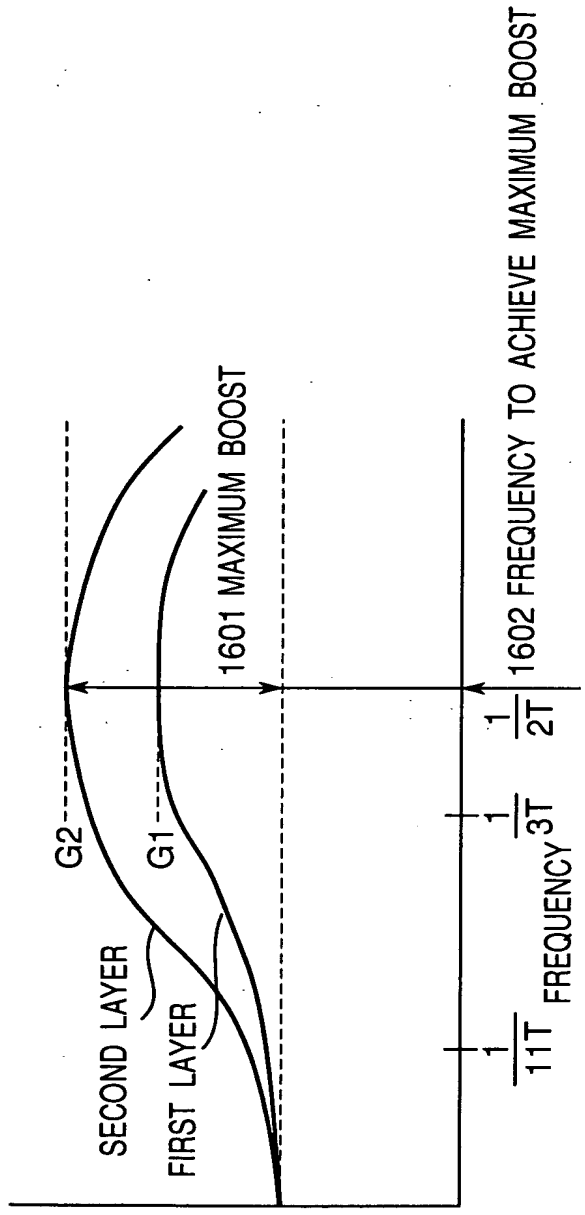


Fig. 16A

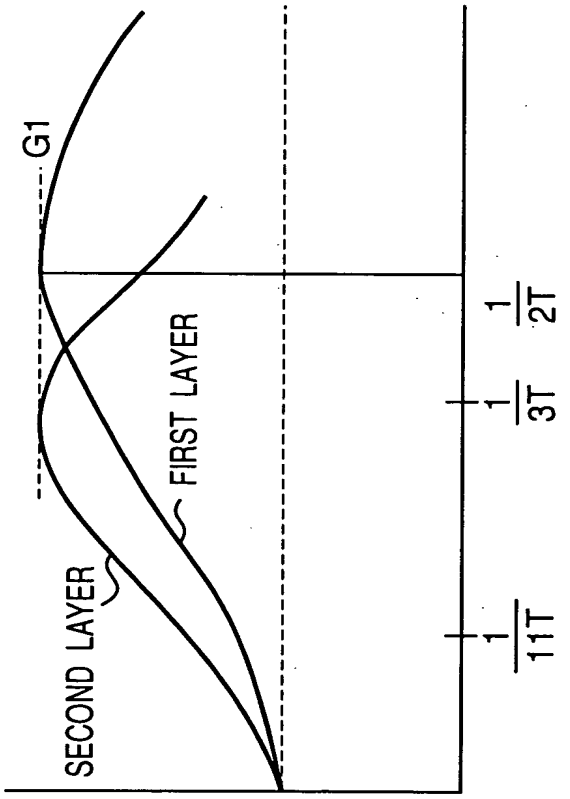


Fig. 16B

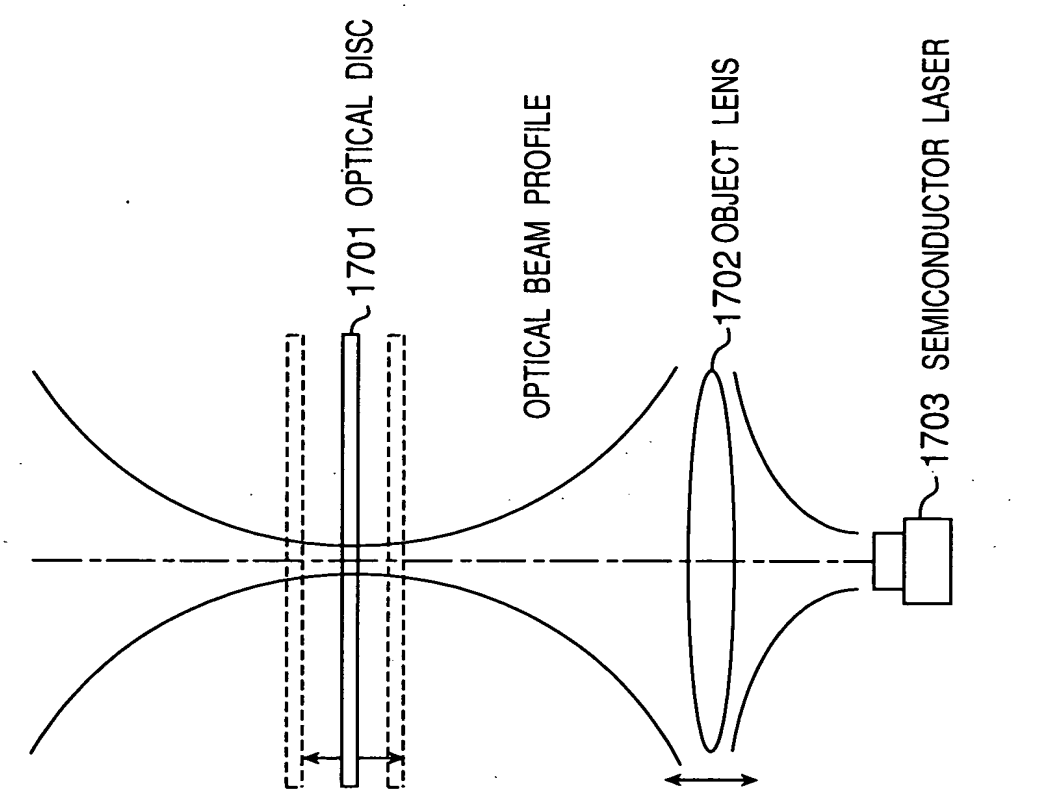

1701 OPTICAL DISC
OPTICAL BEAM PROFILE
1702 OBJECT LENS
1703 SEMICONDUCTOR LASER
Z
FOCUS POSITION

Fig.17

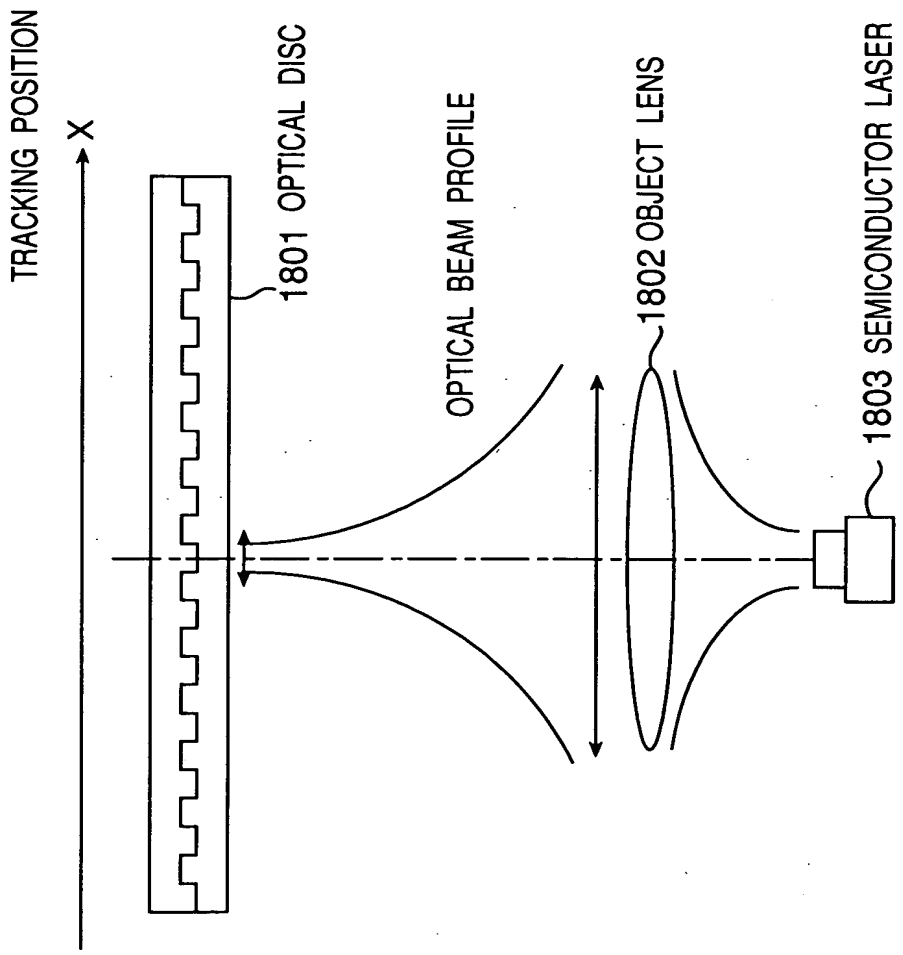

TRACKING POSITION
X
1801 OPTICAL DISC
OPTICAL BEAM PROFILE
1802 OBJECT LENS
1803 SEMICONDUCTOR LASER

Fig.18

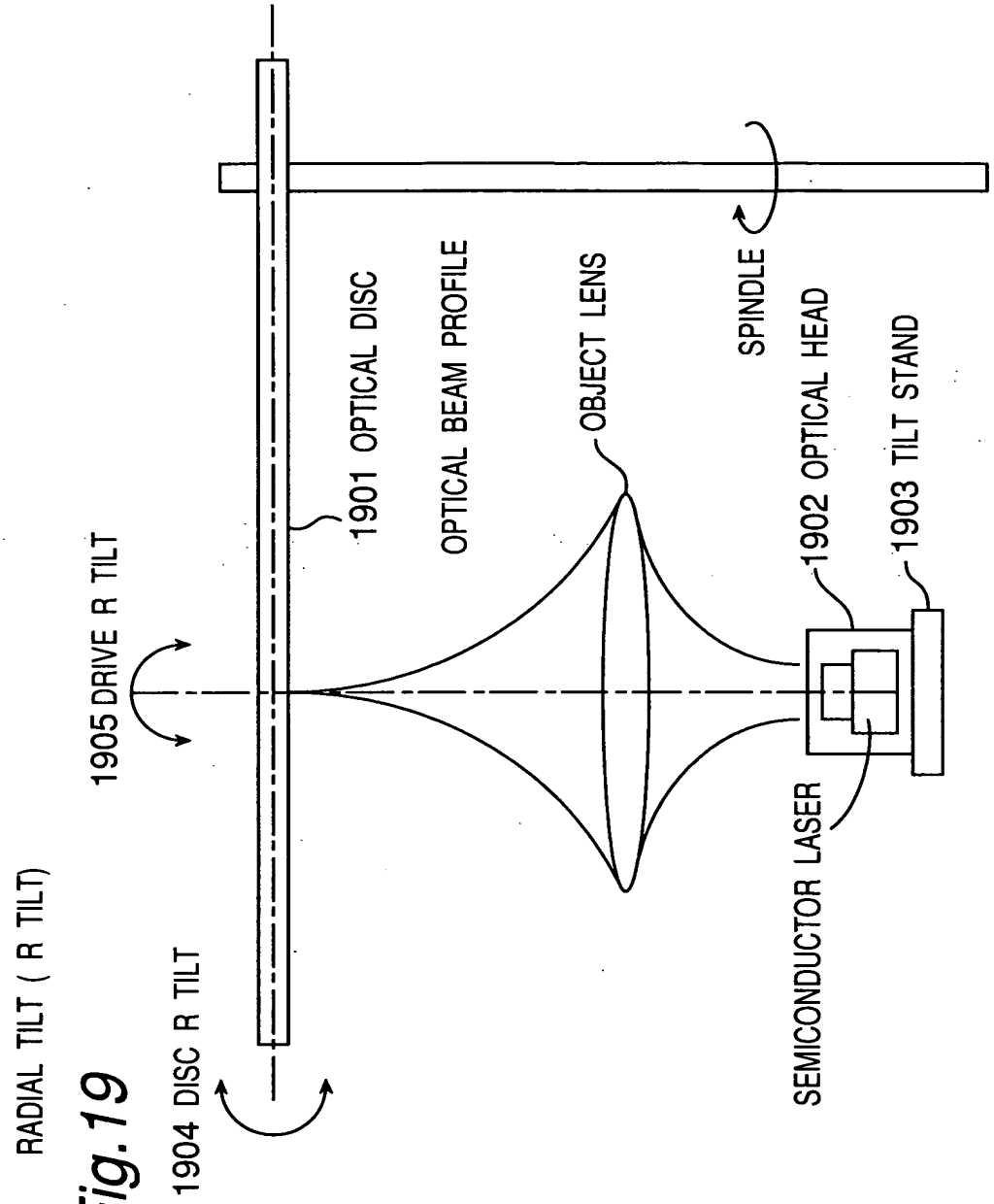

RADIAL TILT (R TILT)
1905 DRIVE R TILT
1904 DISC R TILT
1901 OPTICAL DISC
OPTICAL BEAM PROFILE
OBJECT LENS
SPINDLE
1902 OPTICAL HEAD
1903 TILT STAND
SEMICONDUCTOR LASER

Fig.19

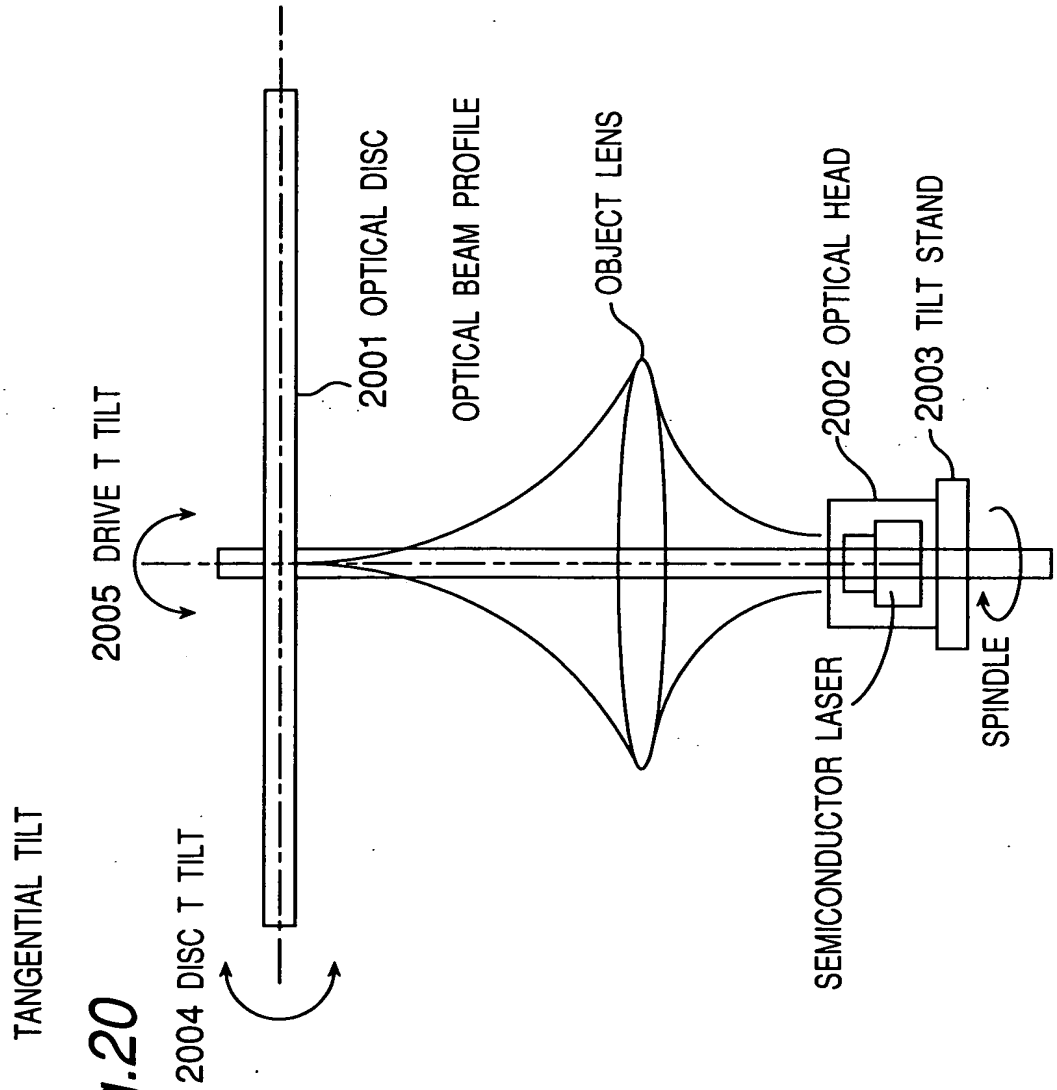

TANGENTIAL TILT
2004 DISC T TILT
2005 DRIVE T TILT
2001 OPTICAL DISC
OPTICAL BEAM PROFILE
OBJECT LENS
2002 OPTICAL HEAD
2003 TILT STAND
SEMICONDUCTOR LASER
SPINDLE

Fig.20

Fig.21

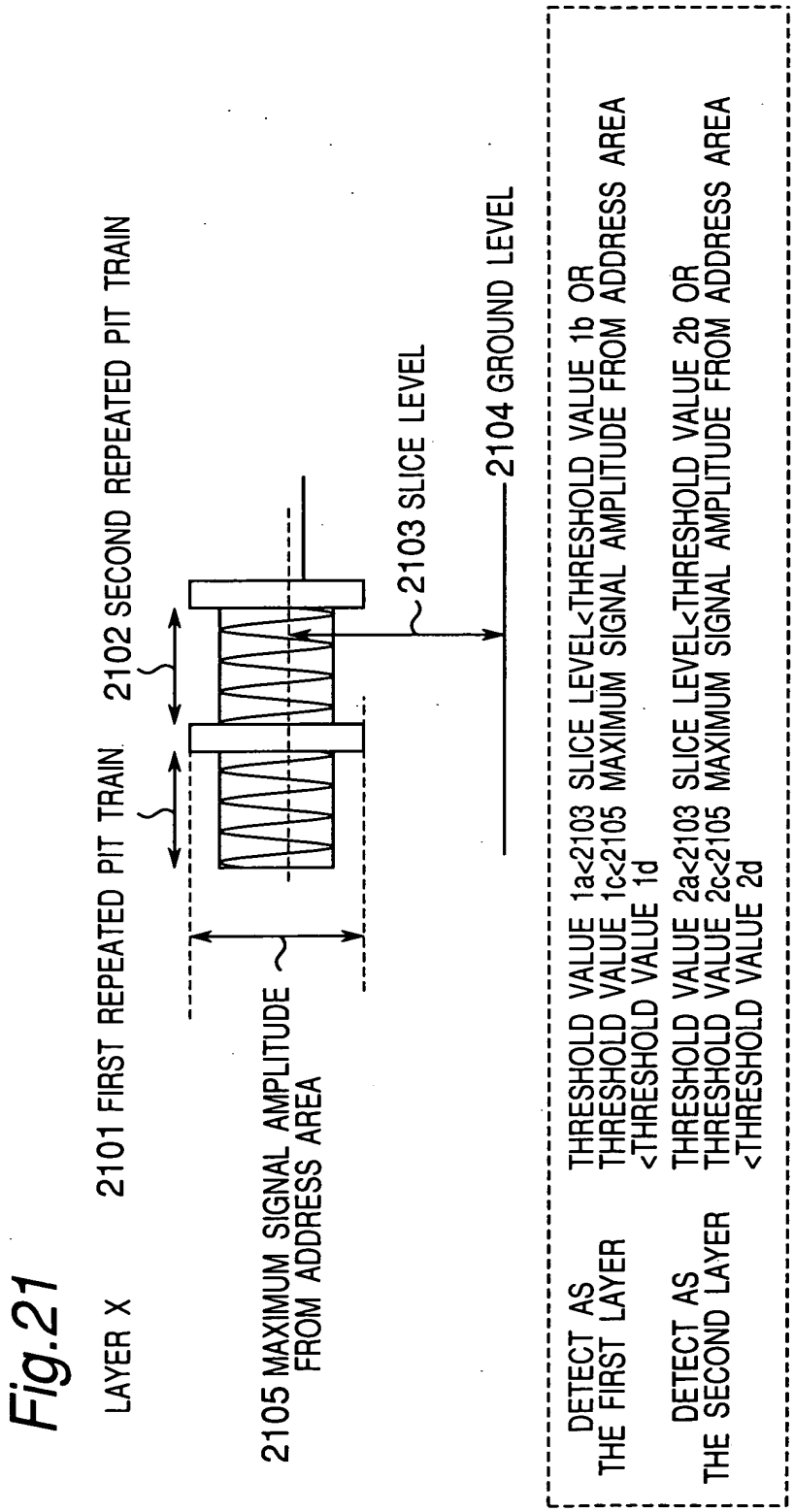

LAYER X
2101 FIRST REPEATED PIT TRAIN
2102 SECOND REPEATED PIT TRAIN
2103 SLICE LEVEL
2104 GROUND LEVEL
2105 MAXIMUM SIGNAL AMPLITUDE FROM ADDRESS AREA
DETECT AS THE FIRST LAYER
THRESHOLD VALUE 1a<2103 SLICE LEVEL<THRESHOLD VALUE 1b OR
THRESHOLD VALUE 1c<2105 MAXIMUM SIGNAL AMPLITUDE FROM ADDRESS AREA
<THRESHOLD VALUE 1d
DETECT AS THE SECOND LAYER
THRESHOLD VALUE 2a<2103 SLICE LEVEL<THRESHOLD VALUE 2b OR
THRESHOLD VALUE 2c<2105 MAXIMUM SIGNAL AMPLITUDE FROM ADDRESS AREA
<THRESHOLD VALUE 2d

Fig.22

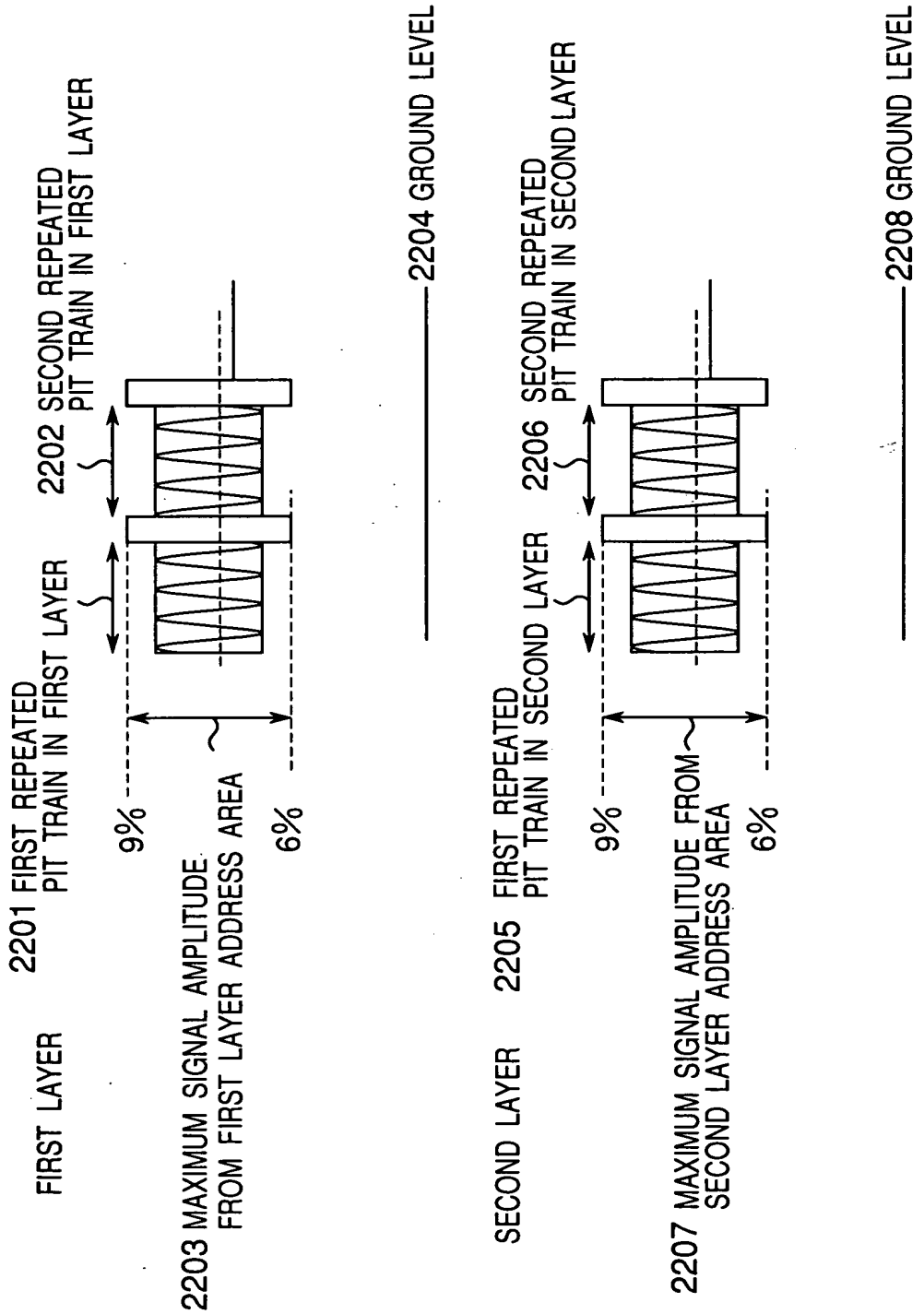

FIRST LAYER
2201 FIRST REPEATED PIT TRAIN IN FIRST LAYER
2202 SECOND REPEATED PIT TRAIN IN FIRST LAYER
2203 MAXIMUM SIGNAL AMPLITUDE FROM FIRST LAYER ADDRESS AREA
9%
6%
2204 GROUND LEVEL
SECOND LAYER
2205 FIRST REPEATED PIT TRAIN IN SECOND LAYER
2206 SECOND REPEATED PIT TRAIN IN SECOND LAYER
2207 MAXIMUM SIGNAL AMPLITUDE FROM SECOND LAYER ADDRESS AREA
9%
6%
2208 GROUND LEVEL

Fig.23

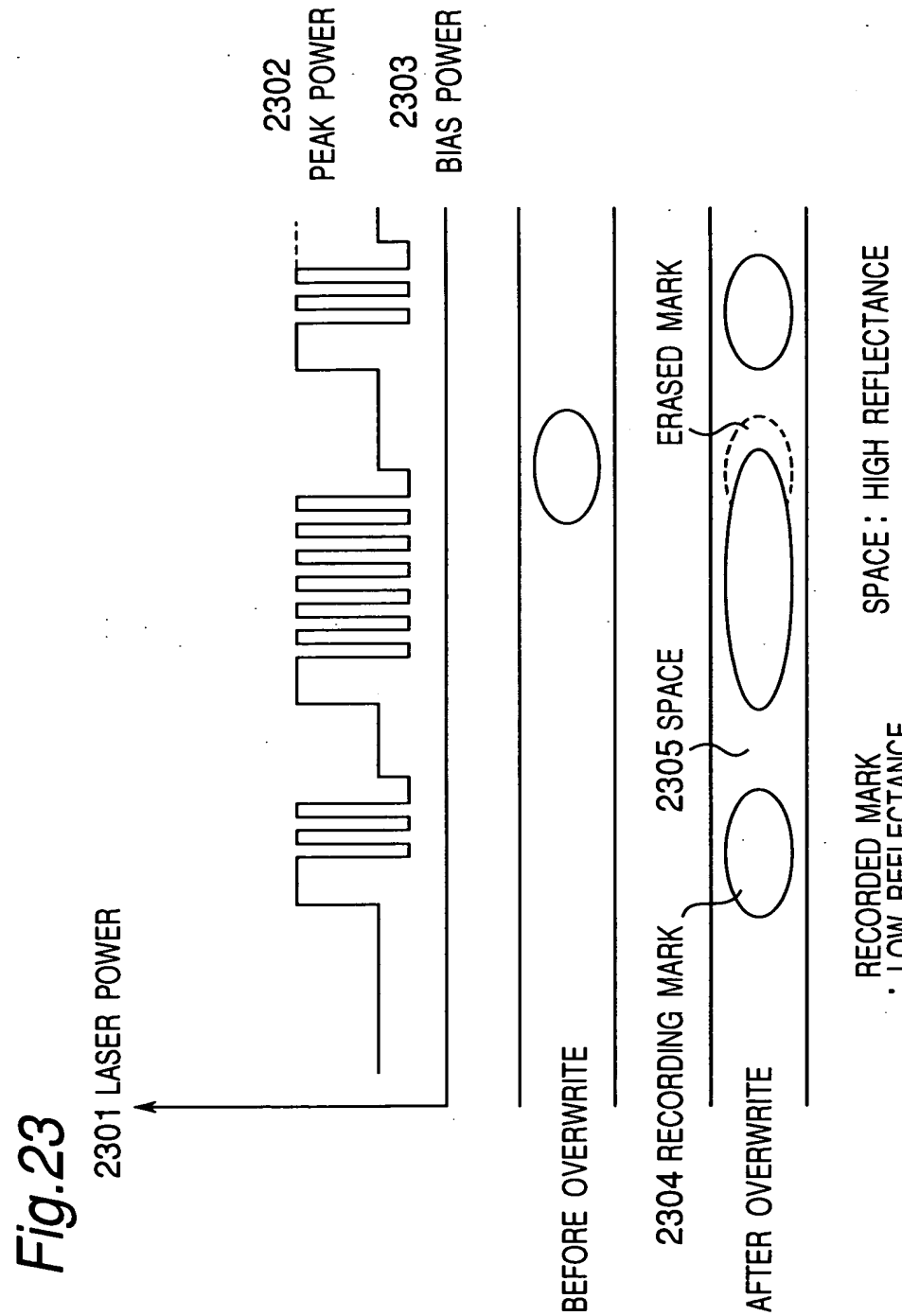
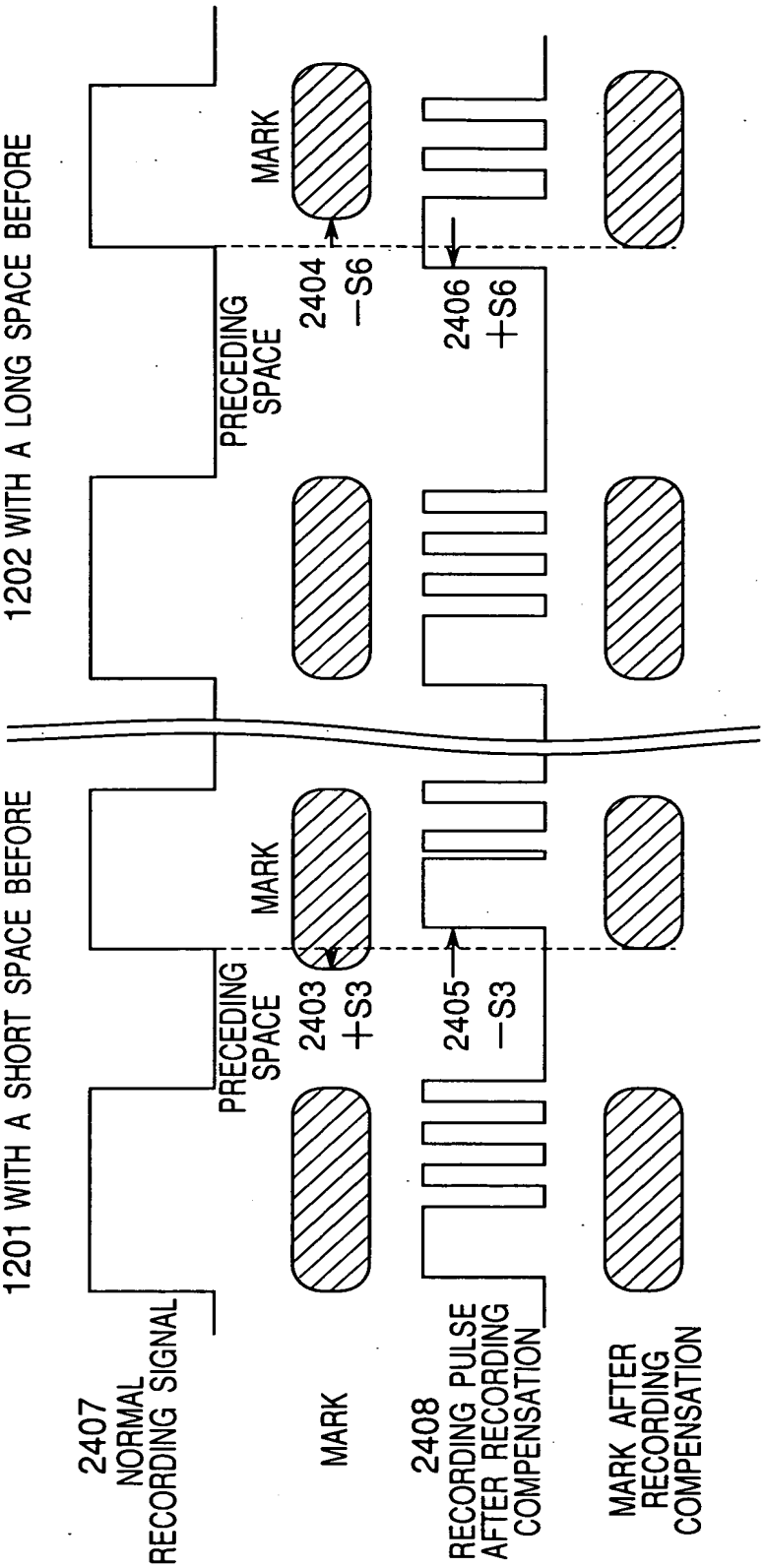

2301 LASER POWER
2302 PEAK POWER
2303 BIAS POWER
BEFORE OVERWRITE
2304 RECORDING MARK
2305 SPACE
ERASED MARK
AFTER OVERWRITE
RECORDED MARK : LOW REFLECTANCE
SPACE : HIGH REFLECTANCE

Fig.24


1201 WITH A SHORT SPACE BEFORE
1202 WITH A LONG SPACE BEFORE
PRECEDING SPACE
MARK
2403 +S3
2404 −S6
2405 −S3
2406 +S6
2407 NORMAL RECORDING SIGNAL
MARK
2408 RECORDING PULSE AFTER RECORDING COMPENSATION
MARK AFTER RECORDING COMPENSATION

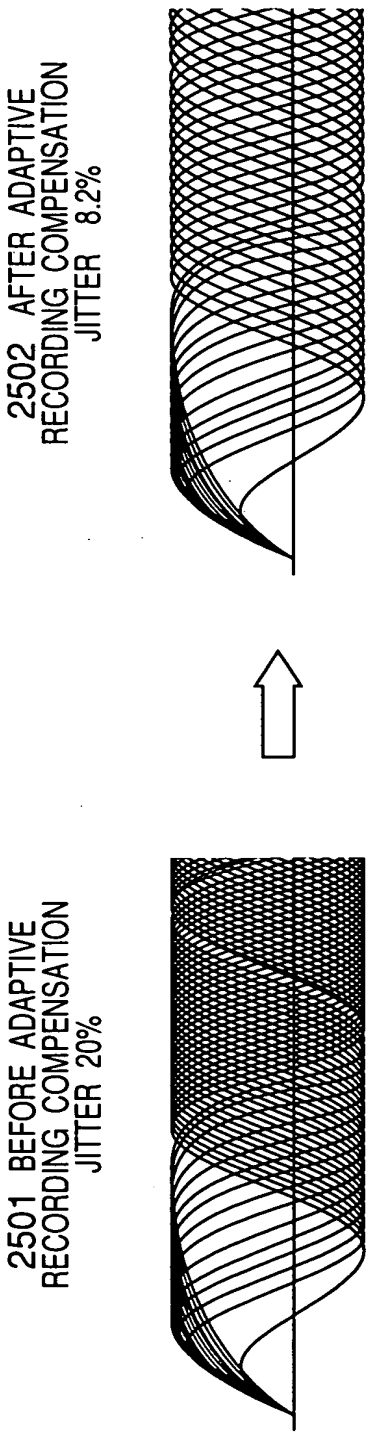
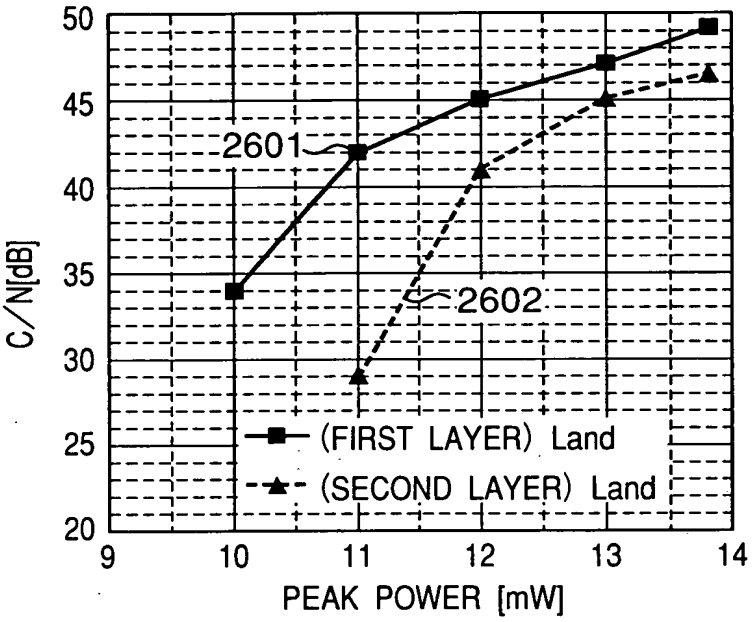

2502 AFTER ADAPTIVE
RECORDING COMPENSATION
JITTER 8.2%
2501 BEFORE ADAPTIVE
RECORDING COMPENSATION
JITTER 20%

Fig.25

Fig.26


50
45
40
35
30
25
20
C/N[dB]
9
10
11
12
13
14
PEAK POWER [mW]
2601
2602
(FIRST LAYER) Land
(SECOND LAYER) Land

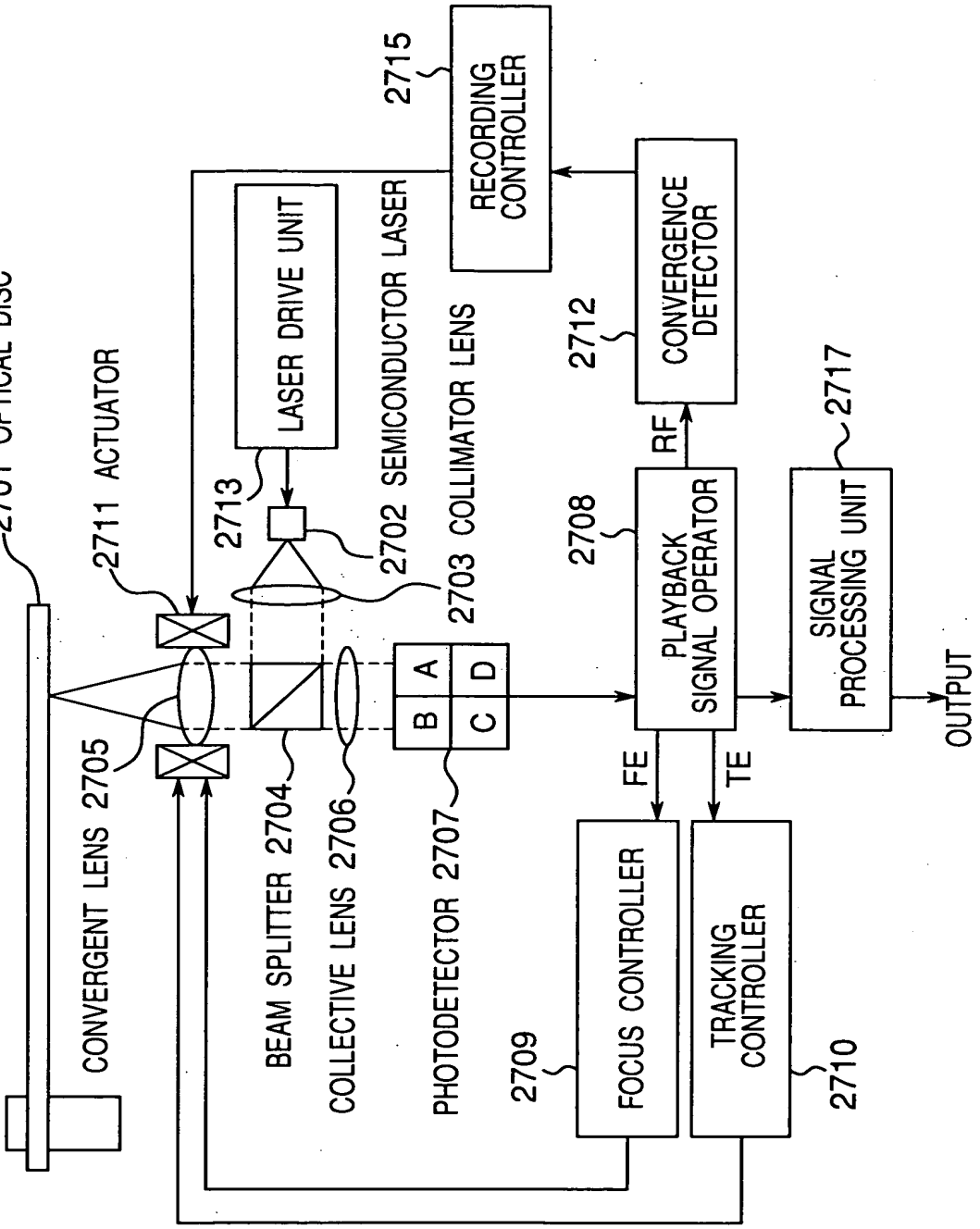

2701 OPTICAL DISC
2711 ACTUATOR
2713
LASER DRIVE UNIT
2702 SEMICONDUCTOR LASER
2703 COLLIMATOR LENS
2715
RECORDING CONTROLLER
2712
CONVERGENCE DETECTOR
RF
2708
PLAYBACK SIGNAL OPERATOR
2717
SIGNAL PROCESSING UNIT
OUTPUT
CONVERGENT LENS 2705
BEAM SPLITTER 2704
COLLECTIVE LENS 2706
PHOTODETECTOR 2707
A
B
C
D
FE
TE
2709
FOCUS CONTROLLER
TRACKING CONTROLLER
2710

Fig.27

Fig.28

2801 FIRST PULSE POSITION

Tsfp

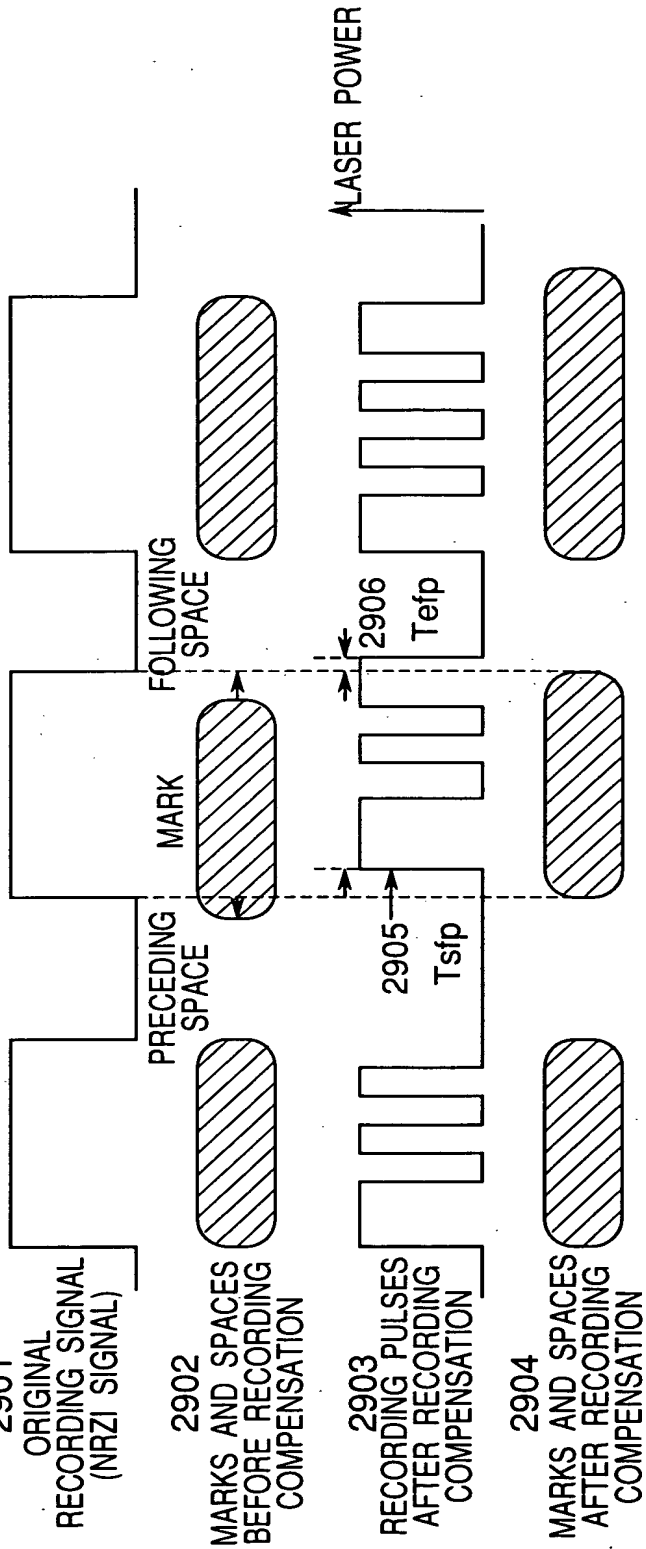
LENGTH OF PRECEDING SPACE \ RECORDING MARK LENGTH	3T	4T	5T	>5T
3T	a	b	c	d
4T	e	f	g	h
5T	i	j	k	l
>5T	m	n	o	p

2802 LAST PULSE POSITION

Telp

LENGTH OF FOLLOWING SPACE \ RECORDING MARK LENGTH	3T	4T	5T	>5T
3T	q	r	s	t
4T	u	v	w	x
5T	y	z	aa	ab
>5T	ac	ad	ae	af

Fig.29


2901
ORIGINAL
RECORDING SIGNAL
(NRZI SIGNAL)
2902
MARKS AND SPACES
BEFORE RECORDING
COMPENSATION
2903
RECORDING PULSES
AFTER RECORDING
COMPENSATION
2904
MARKS AND SPACES
AFTER RECORDING
COMPENSATION
PRECEDING
SPACE
MARK
FOLLOWING
SPACE
2905
Tsfp
2906
Tefp
LASER POWER

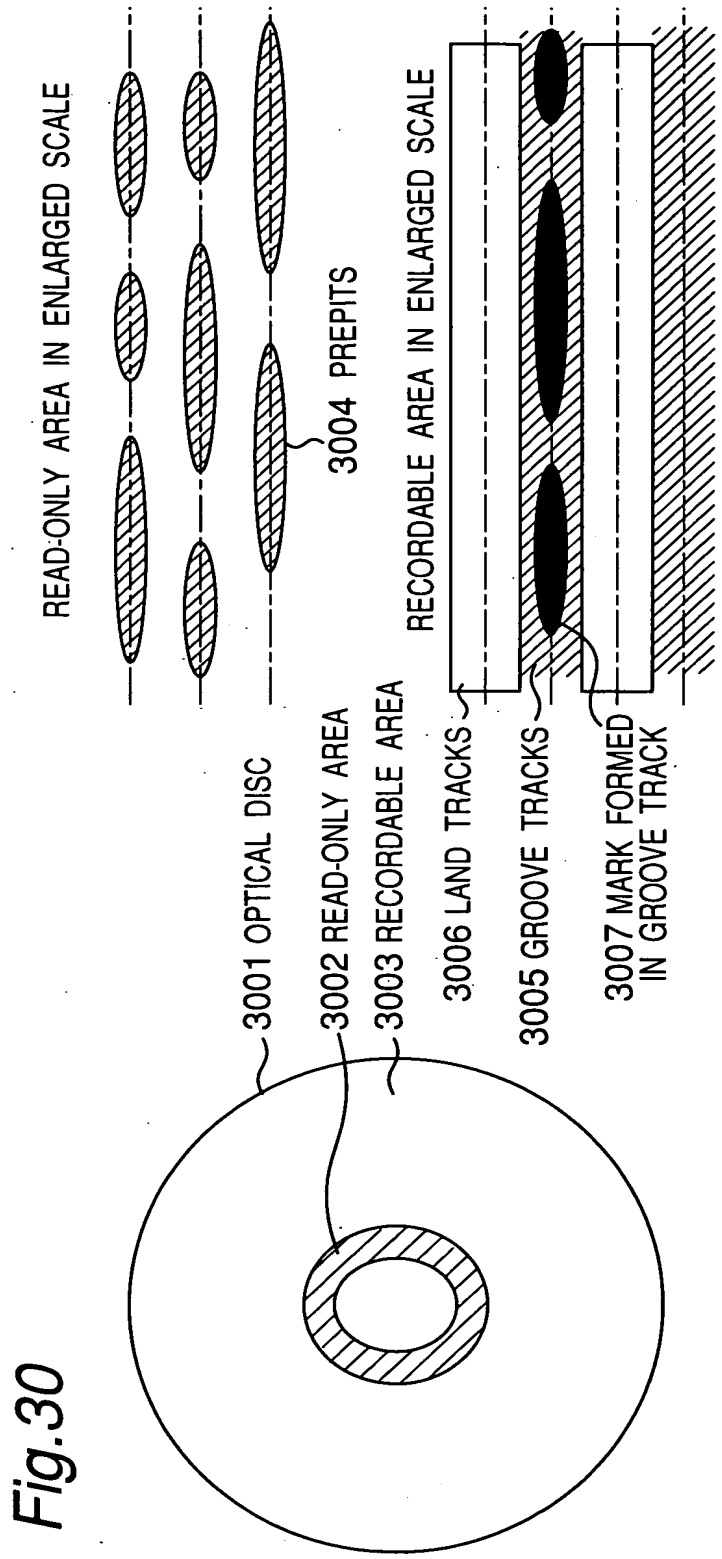

READ-ONLY AREA IN ENLARGED SCALE
3004 PREPITS
RECORDABLE AREA IN ENLARGED SCALE
3001 OPTICAL DISC
3002 READ-ONLY AREA
3003 RECORDABLE AREA
3006 LAND TRACKS
3005 GROOVE TRACKS
3007 MARK FORMED IN GROOVE TRACK

Fig.30

Fig.31

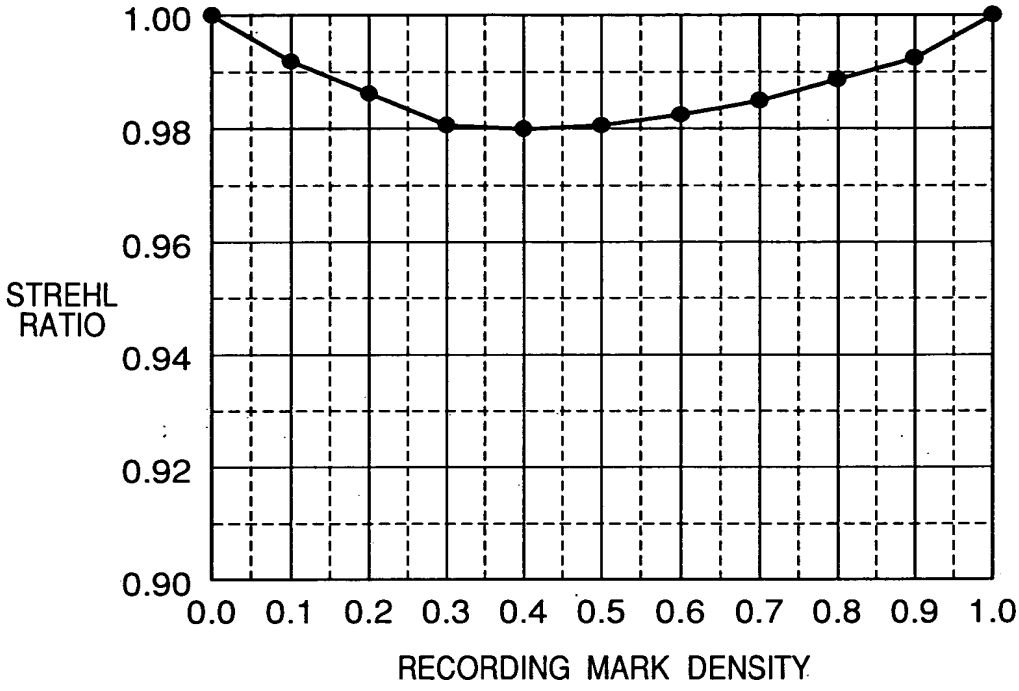

1.00
0.98
0.96
0.94
0.92
0.90
STREHL RATIO
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
RECORDING MARK DENSITY

Fig.32

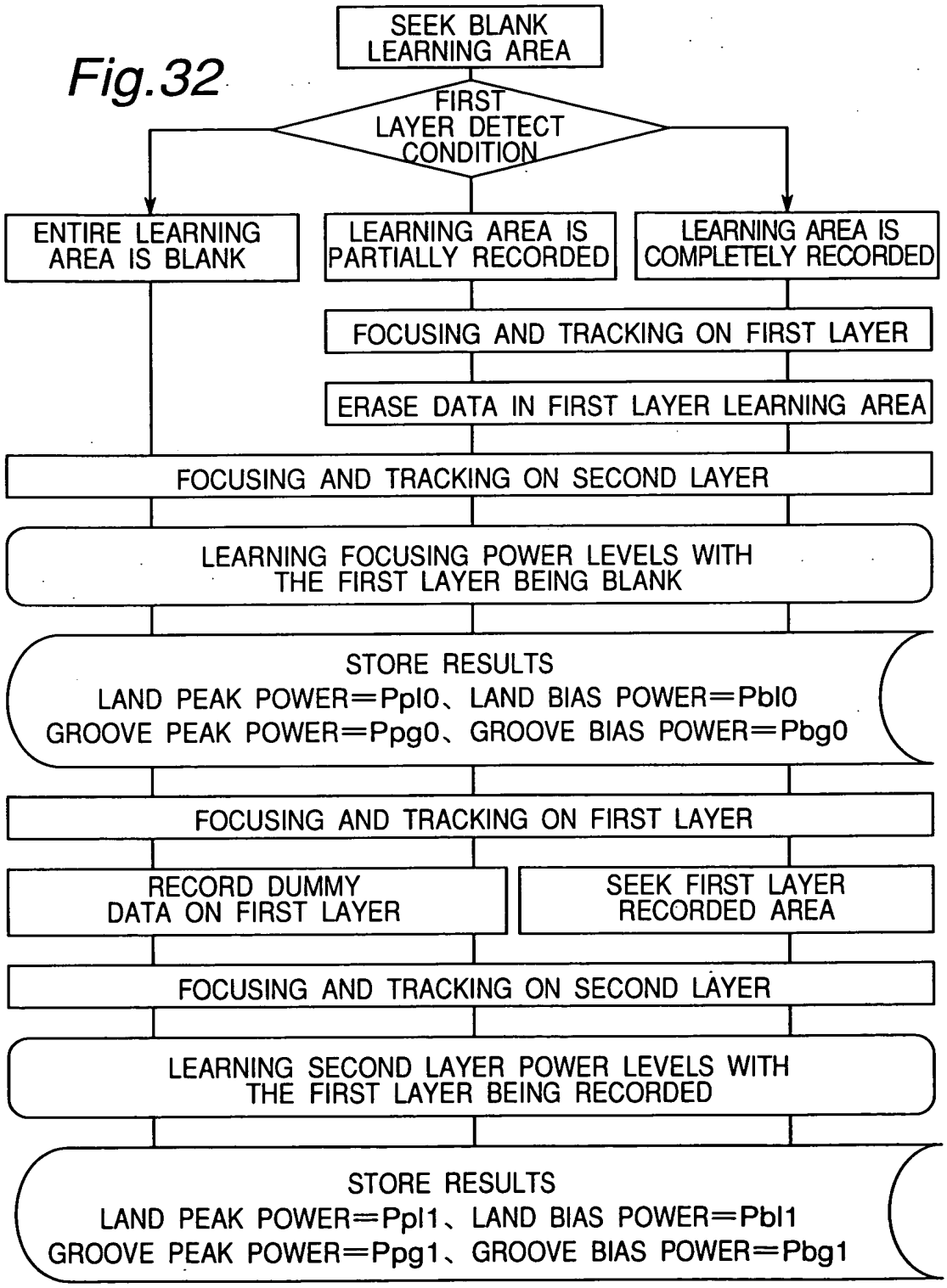

SEEK BLANK LEARNING AREA
FIRST LAYER DETECT CONDITION
ENTIRE LEARNING AREA IS BLANK
LEARNING AREA IS PARTIALLY RECORDED
LEARNING AREA IS COMPLETELY RECORDED
FOCUSING AND TRACKING ON FIRST LAYER
ERASE DATA IN FIRST LAYER LEARNING AREA
FOCUSING AND TRACKING ON SECOND LAYER
LEARNING FOCUSING POWER LEVELS WITH THE FIRST LAYER BEING BLANK
STORE RESULTS
LAND PEAK POWER=Ppl0、LAND BIAS POWER=Pbl0
GROOVE PEAK POWER=Ppg0、GROOVE BIAS POWER=Pbg0
FOCUSING AND TRACKING ON FIRST LAYER
RECORD DUMMY DATA ON FIRST LAYER
SEEK FIRST LAYER RECORDED AREA
FOCUSING AND TRACKING ON SECOND LAYER
LEARNING SECOND LAYER POWER LEVELS WITH THE FIRST LAYER BEING RECORDED
STORE RESULTS
LAND PEAK POWER=Ppl1、LAND BIAS POWER=Pbl1
GROOVE PEAK POWER=Ppg1、GROOVE BIAS POWER=Pbg1

Fig.33

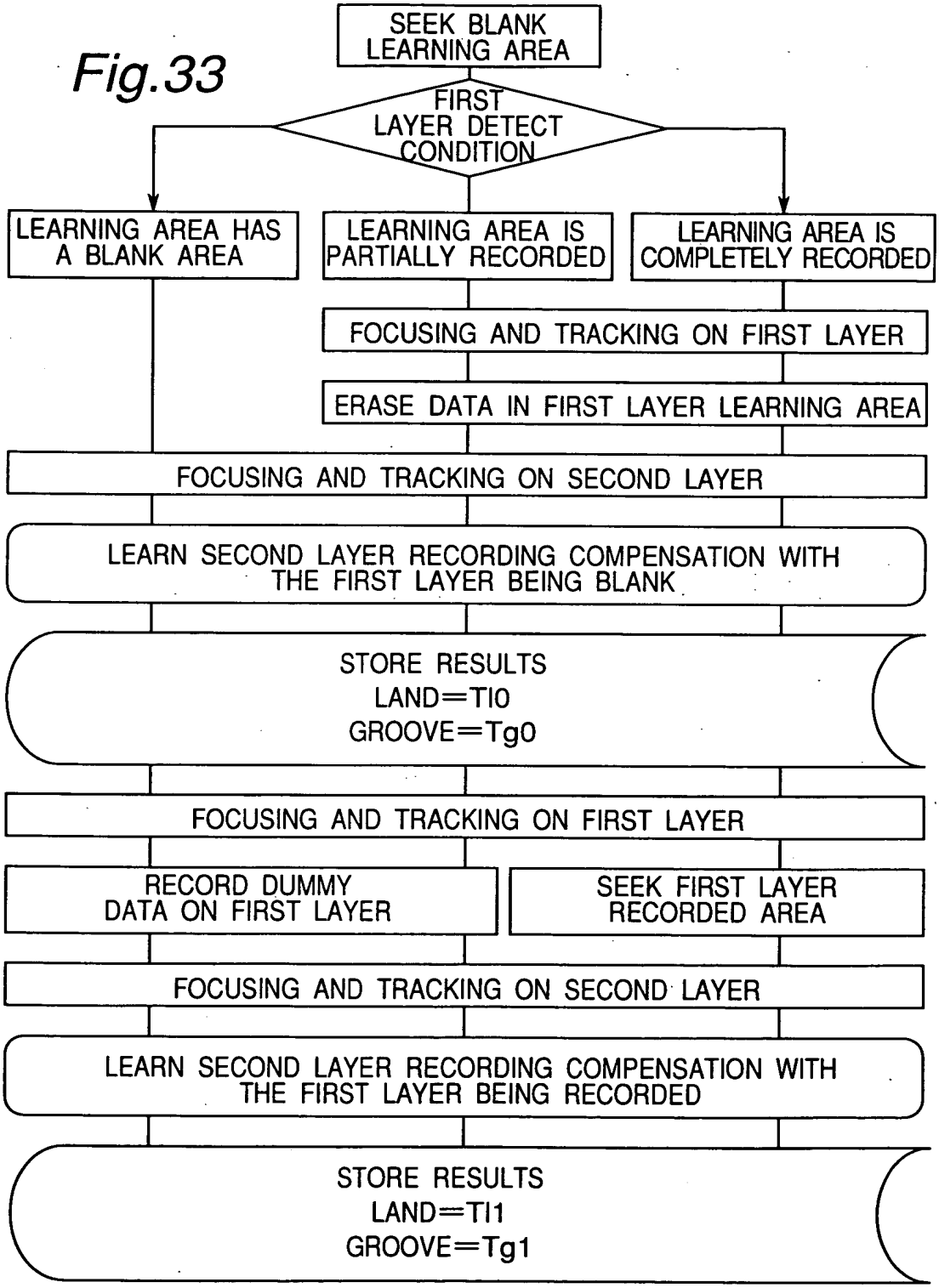

SEEK BLANK LEARNING AREA
FIRST LAYER DETECT CONDITION
LEARNING AREA HAS A BLANK AREA
LEARNING AREA IS PARTIALLY RECORDED
LEARNING AREA IS COMPLETELY RECORDED
FOCUSING AND TRACKING ON FIRST LAYER
ERASE DATA IN FIRST LAYER LEARNING AREA
FOCUSING AND TRACKING ON SECOND LAYER
LEARN SECOND LAYER RECORDING COMPENSATION WITH THE FIRST LAYER BEING BLANK
STORE RESULTS
LAND=TI0
GROOVE=Tg0
FOCUSING AND TRACKING ON FIRST LAYER
RECORD DUMMY DATA ON FIRST LAYER
SEEK FIRST LAYER RECORDED AREA
FOCUSING AND TRACKING ON SECOND LAYER
LEARN SECOND LAYER RECORDING COMPENSATION WITH THE FIRST LAYER BEING RECORDED
STORE RESULTS
LAND=TI1
GROOVE=Tg1

Fig.34

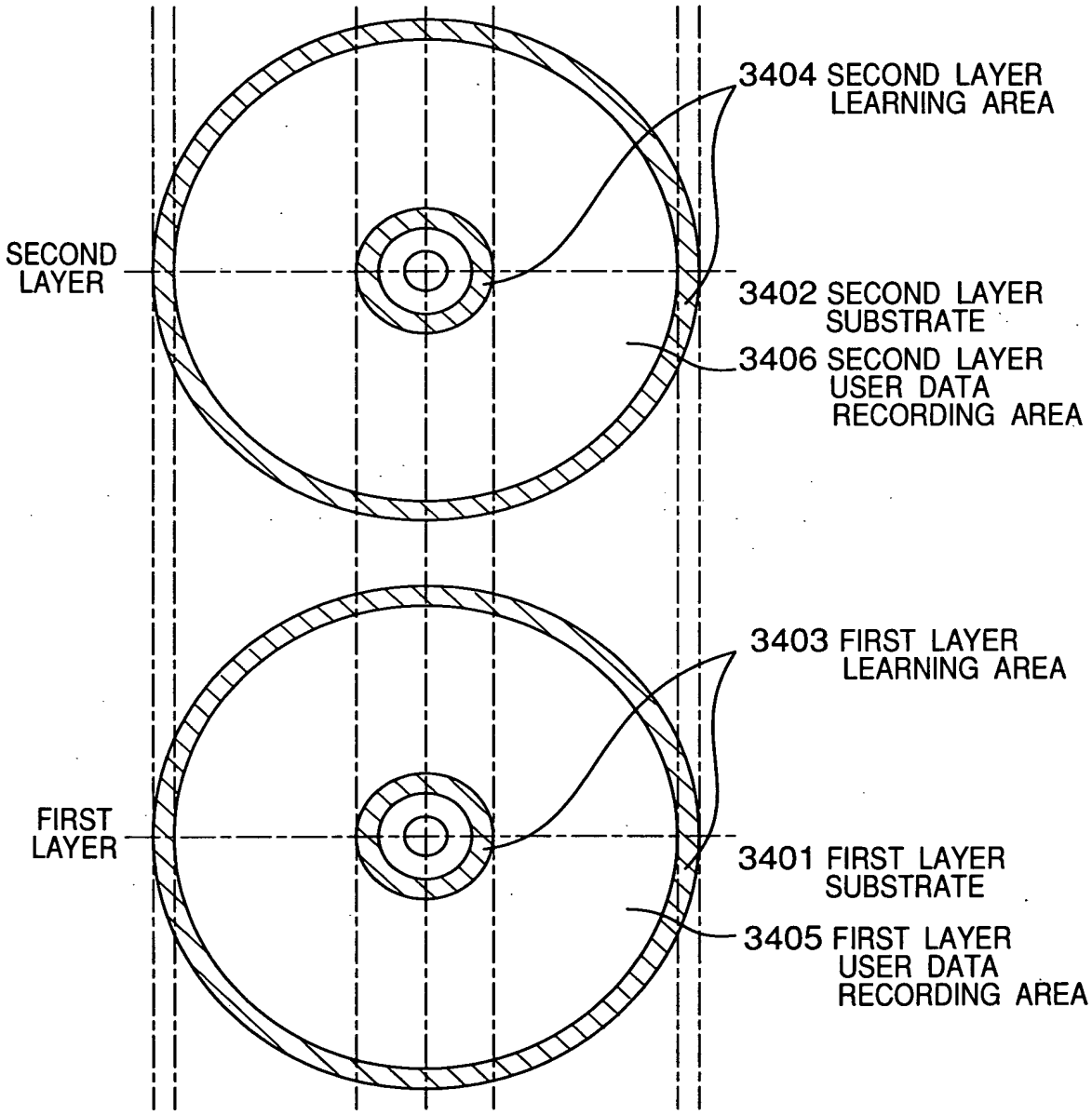

3404 SECOND LAYER LEARNING AREA
SECOND LAYER
3402 SECOND LAYER SUBSTRATE
3406 SECOND LAYER USER DATA RECORDING AREA
3403 FIRST LAYER LEARNING AREA
FIRST LAYER
3401 FIRST LAYER SUBSTRATE
3405 FIRST LAYER USER DATA RECORDING AREA

Fig.35

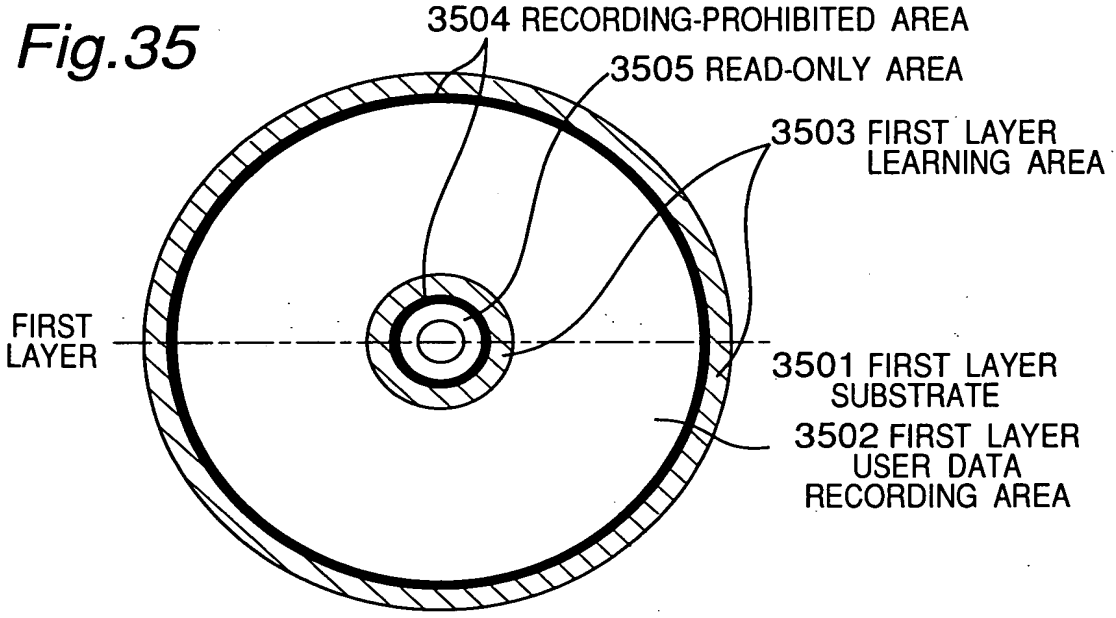

3504 RECORDING-PROHIBITED AREA
3505 READ-ONLY AREA
3503 FIRST LAYER LEARNING AREA
FIRST LAYER
3501 FIRST LAYER SUBSTRATE
3502 FIRST LAYER USER DATA RECORDING AREA

Fig.36

3605 RECORDING COMPENSATION TABLE T10

3601
FIRST PULSE POSITION BEFORE RECORDING FIRST LAYER
Tsfp

LENGTH OF PRECEDING SPACE \ RECORDING MARK LENGTH	3T	4T	5T	>5T
3T	A1	B1	C1	D1
4T	E1	F1	G1	H1
5T	I1	J1	K1	L1
>5T	M1	N1	O1	P1

3602
LAST PULSE POSITION BEFORE RECORDING FIRST LAYER
Telp

LENGTH OF FOLLOWING SPACE \ RECORDING MARK LENGTH	3T	4T	5T	>5T
3T	Q1	R1	S1	T1
4T	U1	V1	W1	X1
5T	Y1	Z1	Aa1	Ab1
>5T	Ac1	Ad1	Ae1	Af1

3606 RECORDING COMPENSATION TABLE T11

3603
FIRST PULSE POSITION BEFORE RECORDING FIRST LAYER
Tsfp

LENGTH OF PRECEDING SPACE \ RECORDING MARK LENGTH	3T	4T	5T	>5T
3T	A2	B2	C2	D2
4T	E2	F2	G2	H2
5T	I2	J2	K2	L2
>5T	M2	N2	O2	P2

3604
LAST PULSE POSITION BEFORE RECORDING FIRST LAYER
Telp

LENGTH OF FOLLOWING SPACE \ RECORDING MARK LENGTH	3T	4T	5T	>5T
3T	Q2	R2	S2	T2
4T	U2	V2	W2	X2
5T	Y2	Z2	Aa2	Ab2
>5T	Ac2	Ad2	Ae2	Af2